

INSTRUCTION MANUAL

PRELIMINARY
OPERATION MANUAL

OSCILLOSCOPE DEVIATION MONITOR
MODEL ODM-1

Manual No. 1-500783-157



SINGER
INSTRUMENTATION



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MODEL ODM-1**

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4/70

**The Singer Company, Electronic Products Division
Gertsch Operation**

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- | | |
|--|--|
| 1. Model or Type | 5. Approximate date instrument was placed in operation |
| 2. Serial Number | 6. Approximate number of hours of use |
| 3. Description of trouble ⁽²⁾ | 7. Has maintenance action been previously requested? |
| 4. Test instruments used | 8. Other comments |

Upon receipt of this information our Service Department will send you service data or shipping instructions. Upon receipt of shipping instructions forward the instrument to the factory prepaid. If requested, an estimate of charges will be made before work begins.

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(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

TABLE OF CONTENTS

Section	Page
I GENERAL DESCRIPTION	1-1
II INSTALLATION	2-1
III OPERATING INSTRUCTIONS	3-1
IV THEORY OF OPERATION	4-1
V MAINTENANCE	5-1
VI SCHEMATIC DIAGRAMS	6-1
VII PARTS LIST	7-1

LIST OF TABLES

Table	Page
1-1. Specifications	1-1
3-1. Operating Controls, Indicators and Connectors	3-1

LIST OF ILLUSTRATIONS

Figure	Page
1-1 Model ODM-1, Oscilloscope Deviation Monitor	i
3-1 Operating Controls, Indicators and Connectors	3-4
3-2 Frequency Controls Setup	3-5
3-3 FM Deviation Measurement — Quick Set-up	3-7
3-4 Frequency Controls Setup	3-8
3-5 Frequency Controls Setup	3-8
3-6 Narrowband Internal Modulation WITH External RF	3-11
Source — Quick Set-up	
3-7 Wideband Internal Modulation WITH External RF	3-13
Source — Quick Set-up	
3-8 Deviation Correction Chart	3-14
3-9 Frequency Controls Setup	3-15
3-10 Frequency Controls Setup	3-16
3-11 Narrowband Internal Modulation WITHOUT External	3-17
RF Source — Quick Setup	
3-12 Frequency Controls Setup	3-18
3-13 Wideband Internal Modulation WITHOUT External	3-19
RF Source — Quick Setup	
3-14 Frequency Controls Setup	3-20
3-15 Frequency Controls Setup	3-21
3-16 60KHz Deviation — Quick Setup	3-23
3-17 Frequency Controls Setup	3-24

LIST OF ILLUSTRATIONS (CONT)

Figure		Page
3-18	Two-Tone Modulation — Quick Setup	3-27
3-19	External Modulation Only — Quick Setup	3-29
3-20	Audio Test Tone Generation — Quick Setup	3-31
4-1	ODM Block Diagram	4-2
4-2	Controls Positions for Modulation	4-3
4-3a	Frequency Controls Setup	4-3
4-3b	Frequency Controls Setup	4-4
4-4	Typical Frequency Control Setup	4-4
4-5	I.F. Generation	4-5
5-1	Vertical Amplifier Board	5-2
6-1	Schematic Diagram — ODM-1	6-1
7-1	Parts Location — Overall Assembly	7-1
7-2	Parts Location — Front Panel	7-2
7-3	Parts Location — IF Board	7-3
7-4	Parts Location — Vertical Amplifier Board	7-9
7-5	Parts Location — Horizontal Amplifier Board	7-12
7-6	Parts Location — HV Power Supply Board	7-15

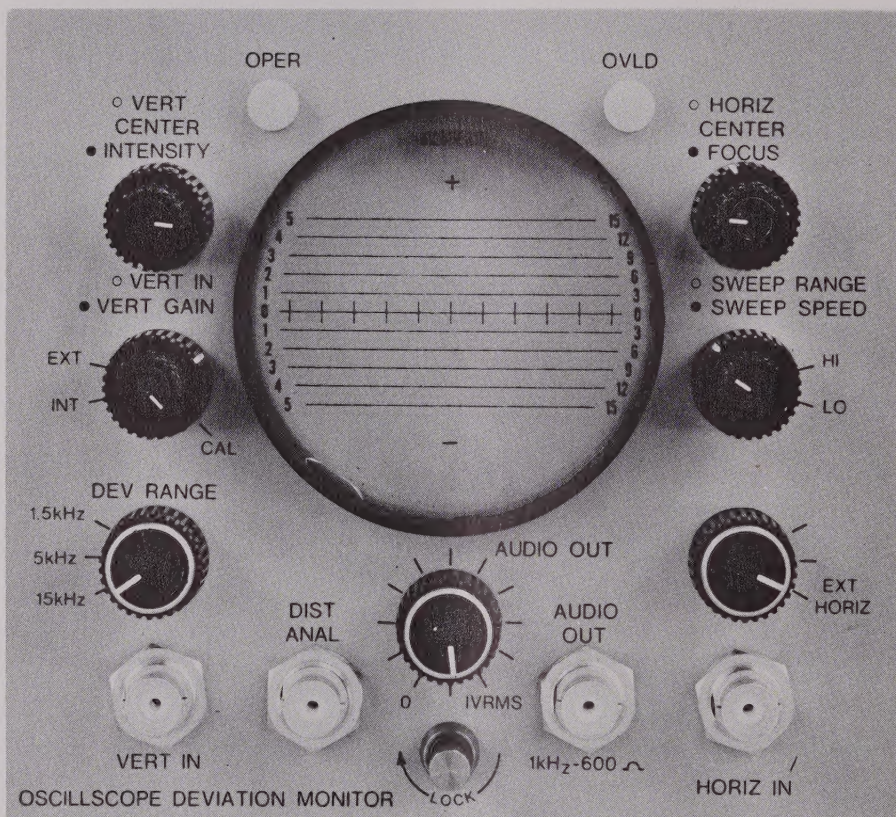


Figure 1-1.

SECTION I

GENERAL DESCRIPTION

The ODM-1 Plug-in module is an auxiliary unit to the Singer Gertsch FM-10 Frequency Meter/Signal Generator. The ODM-1 equips the FM-10 to generate and measure frequency modulation up to 15 KHz deviation (calibrated) and to 60 KHz (uncalibrated). The module may also be used as a general purpose oscilloscope.

In the measuring mode, demodulated FM is displayed directly on an oscilloscope screen calibrated in Kilohertz. In the FM generating modes, modulation is also displayed on the oscilloscope and is controlled by a potentiometer. An FM signal can be generated using an internally supplied tone of 1 KHz, an external tone or a combination of the two. The 1 KHz modulation tone (controllable from 0-1 vrms) is also available at a front connector for transmitter audio tests.

Other facilities provided for monitoring modulation are a loudspeaker presentation of the demodulated signal (controllable in volume) and a front panel signal output jack for connection to a distortion analyzer.

The FM-10/ODM-1 provides a complete and self-contained FM communications field test package in the range 50 KHz to 1000 MHz.

TABLE 1-1. SPECIFICATIONS

DEVIATION RANGE & ACCURACY:	
At 1 KHz Mod. Freq.	0 - 1.5KHz: <u>180Hz $\pm$ 5% of F.S.D.</u> 0 - 5 KHz: <u>180Hz $\pm$ 5% of F.S.D.</u> 0-15 KHz: <u>180Hz $\pm$ 5% of F.S.D.</u>
At 50Hz and 3KHz Mod. Freq.	<u>180Hz $\pm$ 7% of F.S.D.</u>
SENSITIVITY:	
Operate	6 MV rms $\pm$ 3db (10MHz to 500MHz)
OVL D	Approx. 20 MV rms.
INTERNAL / COMBINED MODULATION: (Internal Only)	
Mod. Freq.	<u>1KHz $\pm$ 5%</u>
Dev. Range	0 to 60KHz (min)
COMBINED MOD. MODE: (Internal & External Mod. Combined)	
Mod. Freq.	Ext: 50Hz to 3KHz Int: 1KHz $\pm$ 5%
Dev. Range	0 to 60KHz (min)
EXTERNAL MODULATION:	
Mod. Freq.	50Hz to 3KHz
Dev. Range	0 to 60KHz (min)
Input Impedance:	Approx. 600 ohms
Input Level	Approx. 400 mV rms for 5KHz dev.

TABLE 1-1. SPECIFICATIONS (CONT)

DISTORTION ANALYZER OUTPUT:	
Mod. Freq.	50Hz to 3KHz (3 db)
Output Level	Approx. 280 MV p-p into 1K load at 5KHz dev.
AUDIO OUTPUT:	
Freq.	1KHz $\pm$ 5%
Voltage	1V rms $\pm$ 3db into 600 ohms load Continuously variable 0 - 1V (min)
Source Impedance	600 ohms
Distortion	1% (max)
SCOPE:	
CRT Size	3-inch flat face.
EXTERNAL VERTICAL INPUT:	
Sensitivity	Approx. 70 MV p-p F.S.D. in 1.5KHz range.
Freq. Response	50Hz to 30KHz (3 db)
INPUT IMPEDANCE:	
Attenuator	Approx. 100K Fixed steps 1:3 1/3:10 and continuously variable 10:1
HORIZONTAL:	
Internal	Sweep Range: Lo = 50 to 500Hz Hi = 500 to 5KHz Sweep: Recurrent Type Sync: Internal Automatic
External:	Sensitivity: Approx. 0.6 volts p-p per inch Input Impedance: Approx. 10 meg.
OPERATING TEMPERATURE RANGE:	
-5°C to + 50°C	
WEIGHT:	
Approx. 4-1/2 lbs.	
POWER:	
Supplied by FM-10	

SECTION II

INSTALLATION

PRECAUTION: Early FM-10 units have unventilated cases and will overheat when used with the ODM-1 plug-in. A vented replacement case is supplied with the ODM-1 to owners of unvented mainframes. Ensure that the unvented case has been replaced before installing the ODM-1.

- 2-1. To install the ODM-1 in the FM-10 mainframe, remove the blank plate covering the plug-in aperture by turning the two screws one-quarter turn CCW.
- 2-2. Remove the protective cover on the connector at the rear of the aperture.
- 2-3. Insert ODM-1 until flush with front panel.
- 2-4. Turn the locking pawl clockwise until the plug-in is firmly locked.

SECTION III

OPERATING INSTRUCTIONS

3-1. INTRODUCTION

3-1-1. This section contains instructions only for operating the ODM-1 plug-in module in conjunction with the FM-10 mainframe. Refer to the operating manual for the mainframe (manual number 1-500783-155) for mainframe functions such as power supply connections, rf output control, rf signal input set-ups and beat note zeroing procedure.

3-2. OPERATING CONTROLS, INDICATORS AND CONNECTORS.

3-2-1. The functions of all operating controls, indicators and connectors on the ODM-1 module are described in Table 3-1.

TABLE 3-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS
(Keyed to Figure 3-1)

REF DES	PANEL MARKING	TYPE	FUNCTION
1	VERT CENTER (Outer Knob)	Variable Resistor	Controls vertical position of trace on CRT screen.
	INTENSITY (Inner Knob)	Variable Resistor	Controls brightness of CRT trace. Used with FOCUS control to obtain clear trace.
2	OPER	Indicator Light	Light is off when too little or too much IF signal is applied to the input of the ODM-1. Light is on when IF signal level is in acceptable range.
			NOTE: Oper Light is linked with OVLD indicator so that both lights are never lit at the same time.
3	OVLD	Indicator Light	Light is off at all times except when IF signal is excessive. OVLD goes off and OPER comes on when IF signal is decreased to proper level.
4	HORIZ CENTER (Outer Knob)	Variable Resistor	Controls horizontal position of trace on CRT screen.
4	FOCUS	Variable Resistor	Controls dispersion of beam on CRT screen. Used with INTENSITY control to obtain sharp trace.
5	VERT IN (Outer Knob) EXT INT	Switch, two position	INT Position: In this position, the vertical input of the oscilloscope is switched to the output of the internal demodulator.

TABLE 3-1. OPERATING CONTROLS, INDICATOR AND CONNECTORS (CONT)
(Keyed to Figure 3-1)

REF DES	PANEL MARKING	TYPE	FUNCTION
5	VERT IN (Outer Knob) EXT INT (cont)	Switch, two position	EXT Position: In this position, the vertical input of the oscilloscope is switched to the VERT IN connector.
	VERT GAIN (Inner Knob) CAL	Variable Resistor	Varies vertical gain. CAL Position Fully CW: In this position, vertical gain is calibrated to one of three ranges (1.5, 5 and 15KHz) selected by the DEV RANGE control.
6	SWEEP RANGE HI – LO (Outer Knob)	Switch, two position	Provides coarse control of sweep speed. Is switched out of circuit when an external horizontal input signal is used and MOD MODE is at EXT HORIZ.
	SWEEP SPEED (Inner Knob)	Resistor, variable	Provides fine control of sweep speed.
7	DEV RANGE 1.5KHz, 5KHz, 15KHz	Switch, three position	Selects calibrated vertical input ranges. When VERT GAIN control is in the CAL position, calibration for 5KHz range is at left of CRT screen and calibration for 1,5 and 15KHz ranges is at right.
8	MOD MODE INT / COMB EXT EXT HORIZ	Switch, three position	INT / COMB Position: In this position, the internal 1KHz modulation tone (controlled by INT MOD / AUDIO OUT control) and the EXT MOD / HORIZ IN connectors are switched into the modulation circuit. An external modulation tone supplied to the EXT MOD / HORIZ IN connector is combined with the internal 1KHz tone.
			EXT Position: In this position, the internal 1KHz is removed from the modulation circuit and only the EXT MOD / HORIZ IN connector is in circuit.
			EXT HORIZ: In this position, EXT MOD / HORIZ IN connector is switched into the horizontal drive circuit for external horizontal drive.
9	VERT IN	Connector, BNC	Vertical input jack.
10	DIST ANAL	Connector, BNC	Demodulated audio available at this jack for output to a distortion analyzer.

TABLE 3-1. OPERATING CONTROLS, INDICATORS AND CONNECTORS (CONT)
(Keyed to Figure 3-1)

REF DES	PANEL MARKING	TYPE	FUNCTION
11	INT MOD / AUDIO OUT PWR OFF	Variable Resistor, Switched	Controls internal modulation level when MOD MODE switch is at INT / COMB. Also controls level of 1KHz tone (available at AUDIO OUT connector) from 0 to 1 VRMS. Also controls power to ODM-1 module.
12	AUDIO OUT	Connector, BNC	1KHz signal output available at this jack. Level controlled from 0 to 1 VRMS by INT MOD / AUDIO OUT control.
13	EXT MOD / HORIZ IN	Connector, BNC	This jack is used: (1) to provide an external modulation tone to the modulation circuit when the MOD MODE switch is at INT / COMB or EXT, (2) to provide an external horizontal drive when the MOD MODE switch is at EXT HORIZ.

3-3. PRELIMINARY OSCILLOSCOPE SET-UP PROCEDURE

3-3-1. Switch on power to FM-10 mainframe.

3-3-2. Turn on power to ODM-1 module by turning internal modulation control INT MOD/AUDIO OUT clockwise. Allow approximately 1 minute for warm-up.

3-3-3. Position other controls:

MOD MODE INT
INTENSITY Fully CW

VERT CENTER To mid-range
HORIZ CENTER To mid-range

The trace should now be visible on the screen.

3-3-4. Adjust FOCUS & INTENSITY for sharpest trace.

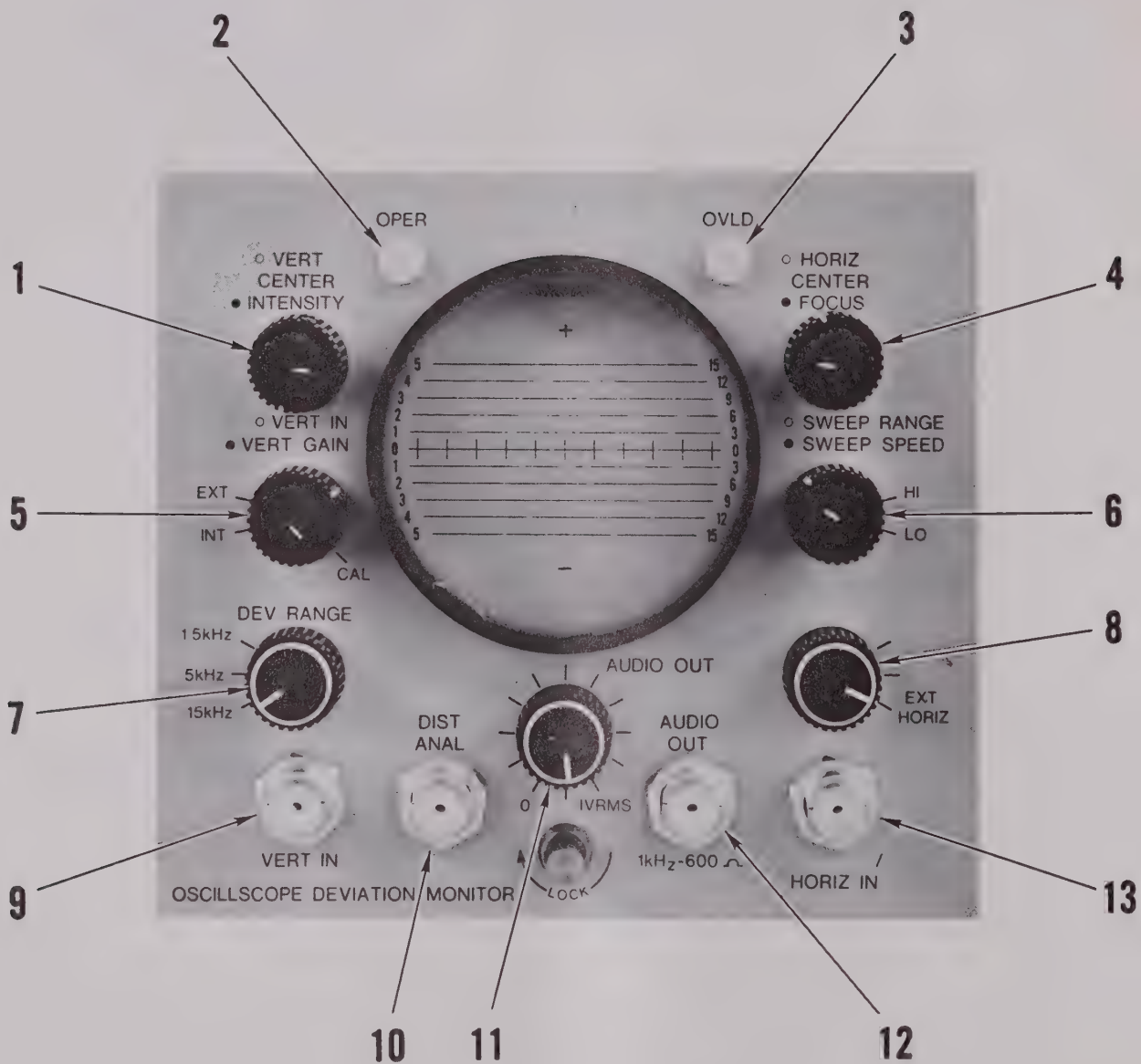


Figure 3-1. Operating Controls, Indicators and Connectors

3-4. FM DEVIATION MEASUREMENT

- 3-4-1. Dial frequency decade controls to frequency of transmitter. Example: Transmitter frequency – 276.0359MHz.
- 3-4-2. Offset FM-10 frequency by ± 2 MHz. (See Figure 3-2.)



Figure 3-2. Frequency Controls Setup

- 3-4-3. Couple transmitter FM output to FM-10 MEAS INPUT connector via antenna provided OR use cable input, with an RFA-60 attenuator in the line.
- 3-4-4. Position other controls as follows:

VERT IN	INT	10MHz (in-out switch)	OUT
VERT GAIN	CAL (fully CW)	DEV RANGE	AS REQUIRED
AUDIO	OUT / MOD		
- 3-4-5. Key transmitter (do not modulate).
- 3-4-6. Increase RF input until operating indicator OPER lights.
- 3-4-7. If overload indicator OVLD lights, decrease RF input until OPER lights and OVLD goes out.
- 3-4-8. Adjust VERT centering to align trace in center of CRT screen.
- 3-4-9. Modulate transmitter by voice or tone.
(Note: 1 KHz tone variable from 0-1 vrms is available at AUDIO OUT. Refer to Section 3-10 for set up).
- 3-4-10. Adjust sweep range and sweep speed for the number of cycles to be displayed.
- 3-4-11. Use appropriate KHz scale on screen to measure peak height of wave. Check waveform visually for presence of distortion.
- 3-4-12. Monitor the modulation aurally by adjusting VOLUME control to desired listening level.
- 3-4-13. To investigate audio distortion further, connect a distortion analyzer to DIST ANAL output.

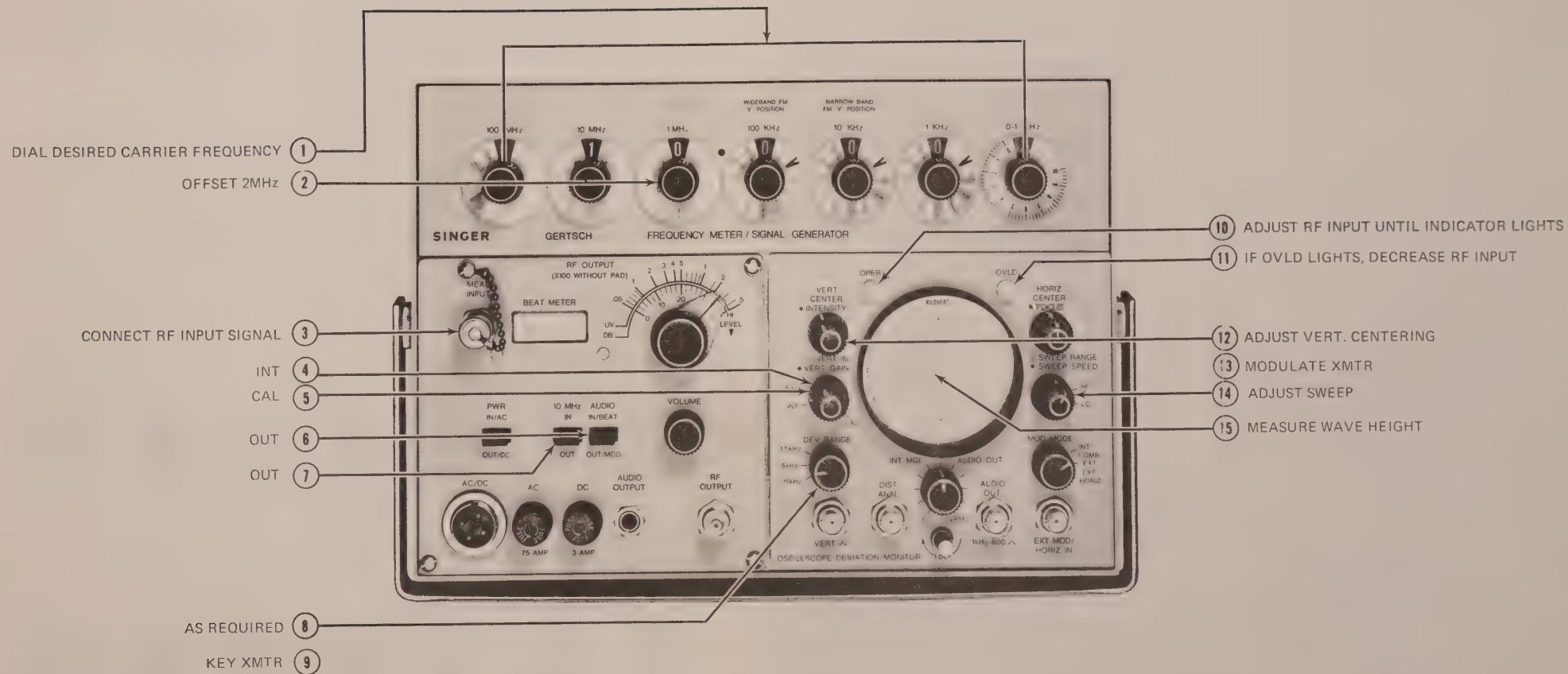


Figure 3-3. FM Deviation Measurement – Quick Set-up

3-5. INTERNAL FM MODULATION – PREFERRED METHOD.

3-5-1. NARROWBAND.

Note: An I.F. signal of 2 MHz is necessary to generate FM modulation. To produce this 2 MHz signal, the preferred method is to set the FM-10 to the transmitter frequency and offset by ± 2 MHz. When the transmitter output signal is connected into the FM-10, an I.F. of 2 MHz is produced. However, the FM-10 can produce the 2 MHz I.F. internally and this method is presented as an alternative in paragraph 3-6.

3-5-2. Couple transmitter RF output to FM-10 MEAS INPUT connector via antenna provided OR use cable input with an RFA-60 attenuator in the line.

3-5-3. Position other controls as follows:

10MHz (in-out switch)	OUT	MOD MODE	INT / COMB
AUDIO	IN / BEAT	DEV RANGE	AS REQUIRED
VERT GAIN	CAL	INT MOD /	CCW (not off)
VERT IN	INT	AUDIO OUT	

3-5-4. Set FM-10 frequency controls to desired carrier frequency.

3-5-5. Adjust frequency of generator (if used) until beat note is heard. If using transmitter, key and observe beat note.

3-5-6. Turn 10 KHz control to V position. The functions of the 10 and 1 KHz controls are now taken over by the 0-1 KHz control.

3-5-7. Turn 0-1 KHz control until zero beat note condition is obtained. Example: For a carrier of 97.3527 MHz, the setting will be 5.27. (See Figure 3-4.)

Note: Due to lack of resolution, the 0-1 KHz can only be set to two significant figures. In this case the setting would be corrected to 5.3.

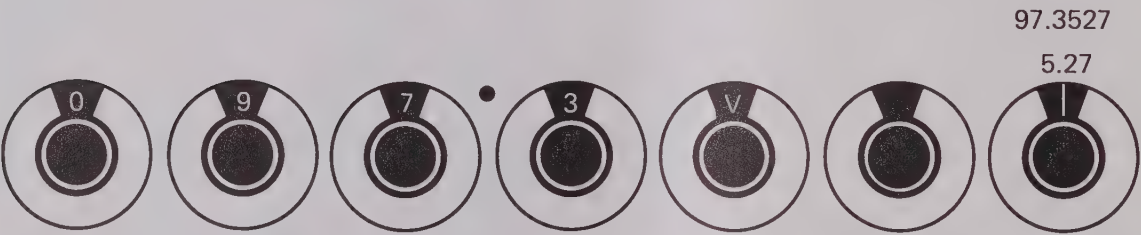


Figure 3-4. Frequency Controls Setup

3-5-8. Offset FM-10 by ± 2 MHz. (See Figure 3-5.)

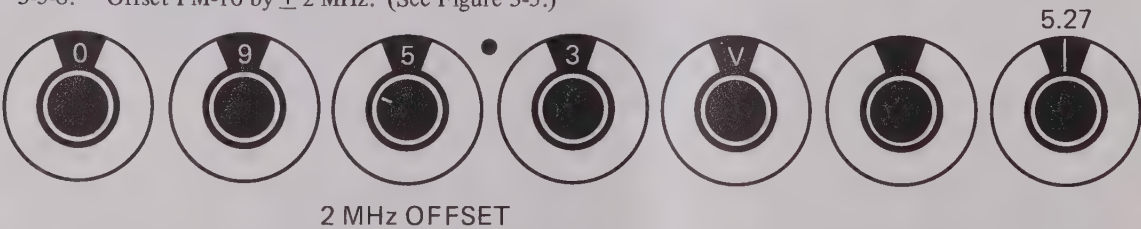


Figure 3-5. Frequency Controls Setup

- 3-5-9. Key transmitter (do not modulate) and increase RF input until operating indicator OPER lights. If overload indicator OVLD lights, decrease RF input until OPER lights and OVLD goes out.
- 3-5-10. Adjust vert centering to align trace in center of screen.
- 3-5-11. Turn INT MOD/AUDIO OUT control CW until wave height reaches the desired deviation.
- 3-5-12. Disconnect signal source from MEAS INPUT.
- 3-5-13. Return FM-10 frequency controls to carrier frequency by removing ± 2 MHz offset.
- 3-5-14. The FM-10/ODM-1 is now generating an FM output of the desired deviation at 97.3527 MHz.
- 3-5-15. WIDEBAND (> 6 KHz).
- 3-5-16. The procedure for wideband deviation is the same as for narrowband except set 100 KHz control to V at para 3-5-6, instead of 10 KHz control.

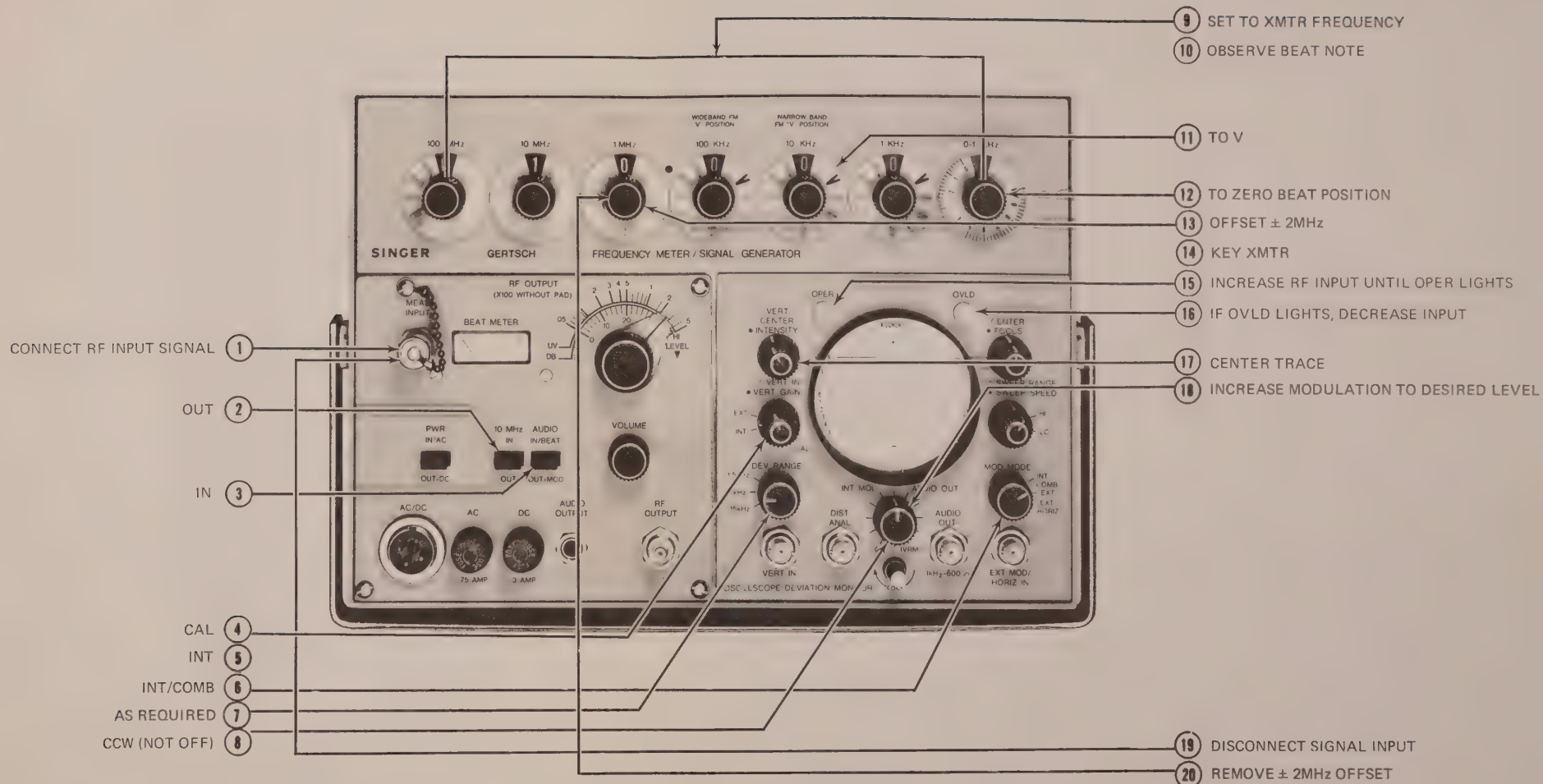
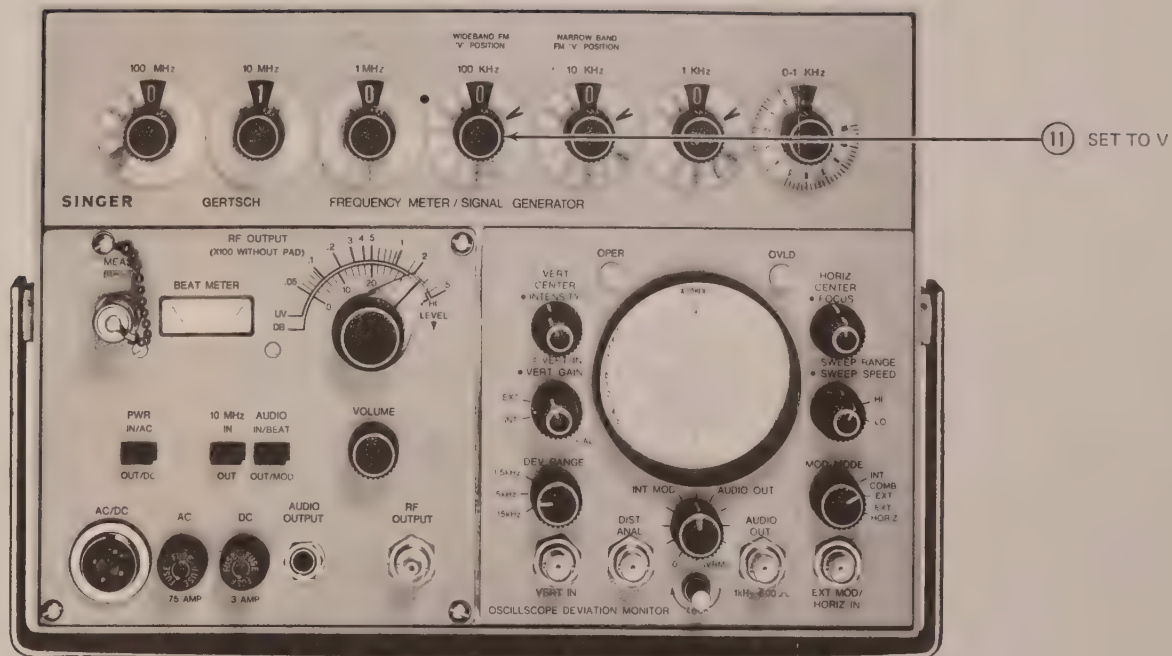


Figure 3-6. Narrowband Internal Modulation WITH External RF Source -- Quick Set-up



REPEAT NARROWBAND SET-UP (FIGURE 3-6) EXCEPT
SET 100KHz CONTROL TO V AT STEP 11.

Figure 3-7. Wideband Internal Modulation WITH External RF Source – Quick Set-up

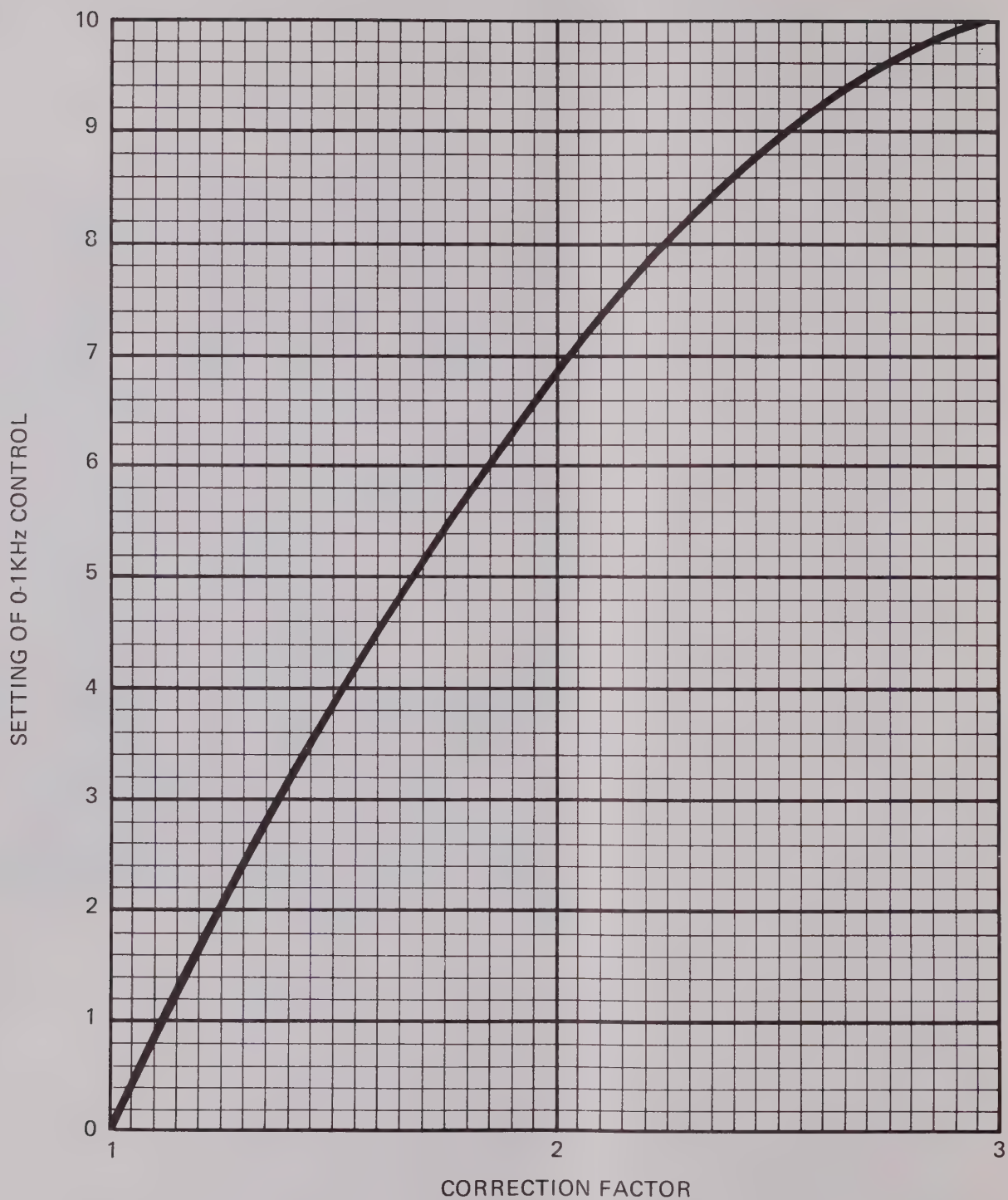


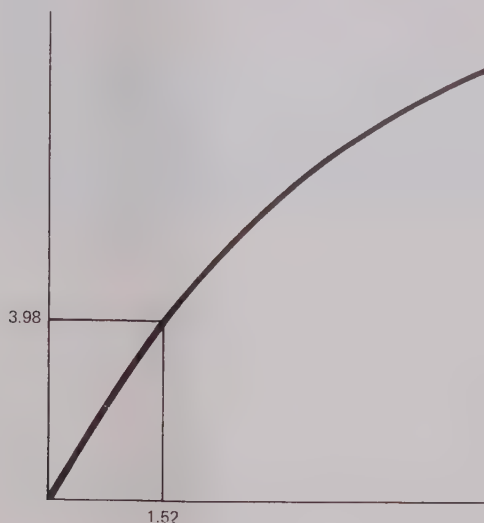
Figure 3-8. Deviation Correction Chart

- 3-6. INTERNAL FM MODULATION – ALTERNATE METHOD. Without external transmitter or RF generator.
- 3-6-1. NARROWBAND (0-6 KHz).
- 3-6-2. Set FM-10 frequency controls to desired carrier frequency. Example: Modulate 273.9398MHz to 5 KHz deviation.
- 3-6-3. Turn 0-1 KHz control to same value as the 10 KHz, 1 KHz and 0-1 KHz controls. (See Figure 3-9).



Figure 3-9. Frequency Controls Setup

- 3-6-4. Take setting of 0-1 KHz control and find correction factor from Figure 3-5.
Example: 0-1 KHz control setting: 3.98. Correction Factor: 1.52



- 3-6-5. Divide correction factor into desired deviation. Example: $5\text{KHz} \div 1.52 = 3.3\text{KHz}$.
Note the value obtained.

- 3-6-6. Position other controls as follows:

Frequency Controls	012.0V00
10MHz (in-out switch)	IN
DEV RANGE	5KHz
VERT IN	INT

VERT GAIN
MOD MODE
INT MOD /
AUDIO OUT

CAL
INT / COMB
CCW (not off)

- 3-6-7. Turn INT MOD/AUDIO OUT control until wave height in Kilohertz reaches the corrected deviation obtained in paragraph 3-6-5. In the example, the corrected deviation is 3.3 KHz. This will become 5 KHz when the 0-1 KHz control is re-set to 3.98 in paragraph 3-6-10.
- 3-6-8. Push 10 MHz (in-out) switch to OUT.
- 3-6-9. Set FM-10 frequency controls to desired carrier frequency.
- 3-6-10. Turn 0-1 KHz control to value obtained in paragraph 3-6-3.



Figure 3-10. Frequency Controls Setup

- 3-6-11. Turn 10 KHz control to V.
- 3-6-12. The FM-10/ODM-1 is now generating 5 KHz deviation at 273.9398 MHz.

- 3-6-13. WIDEBAND > 6 KHz.
- 3-6-14. Set FM-10 frequency controls to desired carrier frequency. Example: Modulate 273.9398MHz to 15 KHz.
- 3-6-15. Turn 0-1 KHz control to same setting as 100 KHz, 10 KHz, and 1 KHz controls. (See Figure 3-12.)



Figure 3-12. Frequency Controls Setup

- 3-6-16. Take setting of 0-1 KHz control and find correction factor from Figure 3-5.
Example: 0-1 KHz control setting: 9.398 Correction Factor: 2.67.
- 3-6-17. Divide correction factor into desired deviation. Example: $15\text{KHz} \div 2.67 = 5.6\text{KHz}$.
Note the value obtained.
- 3-6-18. Position other controls as follows:

Frequency controls	012.V000		VERT GAIN	CAL
10MHz (in-out switch)	IN		MOD MODE	INT / COMB
DEV RANGE	15KHz		INT MOD / AUDIO	CCW
VERT IN	INT		OUT	
- 3-6-19. Turn INT MOD/AUDIO OUT control until wave height reaches the corrected deviation obtained in paragraph 3-6-17 (5.6 KHz).
- 3-6-20. Push 10 MHz (in-out) switch to OUT.
- 3-6-21. Re-set FM-10 frequency controls to carrier frequency.
- 3-6-22. Turn 0-1 KHz control to setting obtained in paragraph 3-6-15.
- 3-6-23. Turn 100 KHz control to V.
- 3-6-24. The FM-10/ODM-1 is now generating 15 KHz deviation at 273.9398 MHz.

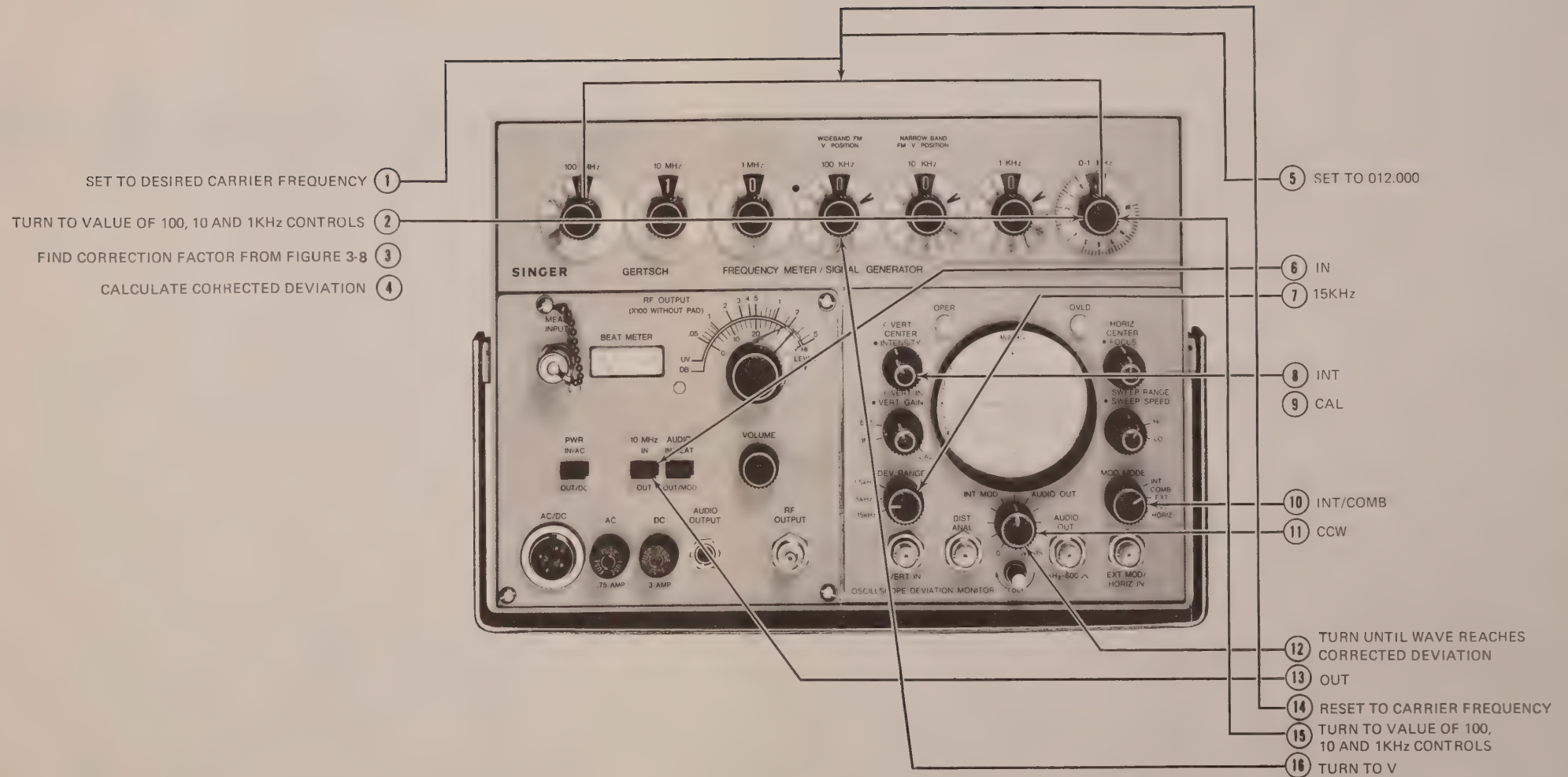


Figure 3-13. Wideband Internal Modulation WITHOUT External RF Source – Quick Set-up

3-7. FM MODULATION TO 60KHz DEVIATION.

Note: The FM-10/ODM-1 provides deviation measurement to 15 KHz. However, deviation as high as 60 KHz can be obtained by the following procedure.

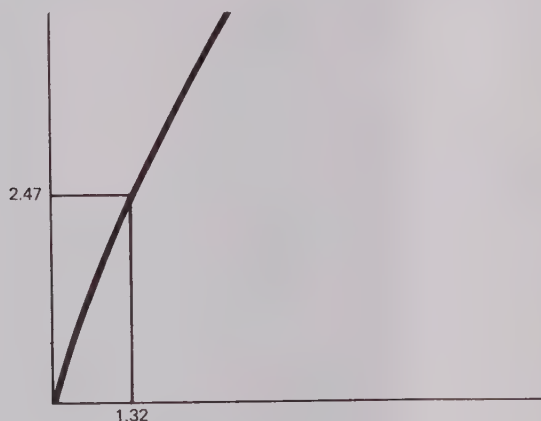
3-7-1. Set FM-10 to desired carrier frequency. Example: Modulate 36.2471MHz to 50KHz deviation.

3-7-2. Turn 0-1 KHz control to same value as the 100, 10 and 1 KHz controls. (See Figure 3-14)



Figure 3-14. Frequency Controls Setup

3-7-3. Take setting of 0-1 KHz control and find correction factor from Figure 3-5.
Example: 0-1 KHz control setting – 2.47. Correction factor: 1.32.



3-7-4. Divide correction factor into one-tenth of the desired deviation.

Example: Desired Deviation: 50KHz
One-tenth desired deviation: 5KHz
Correction Factor: 1.32

$5 \text{ KHz} \div 1.32 = 3.78 \text{ KHz}$ (corrected deviation). Note the value obtained.

3-7-5. Position other controls:

Frequency Controls	012.0V00		VERT IN	INT
10MHz	IN		VERT GAIN	CAL
AUDIO	OUT / MOD		DEV RANGE	5KHz
INT MOD/AUDIO	CCW (not off)		MOD MODE	INT / COMB
OUT				

3-7-6. Turn INT MOD/AUDIO OUT control until wave height reaches the corrected deviation obtained in paragraph 3-7-4. (3.78 KHz in example.)

3-7-7. Push 10 KHz switch to OUT.

3-7-8. Re-set frequency controls to carrier frequency.

3-7-9. Turn 0-1 KHz control to same value as the 100, 10 and 1 KHz controls.

3-7-10. Turn 100 KHz control to V. (See Figure 3-15.)



Figure 3-15. Frequency Controls Setup

3-7-11. The FM-10/ODM-1 is now generating 50 KHz deviation at 36.247 MHz.

Note: In the example, the deviation of 3.78 KHz is set up with the 10 KHz control in the V position. This is multiplied by 10 when the 100KHz control is set to V instead, in paragraph 3-7-10. The deviation thus becomes 37.8KHz. This corresponds to 50KHz when the 0-1KHz control is set to 2.47.

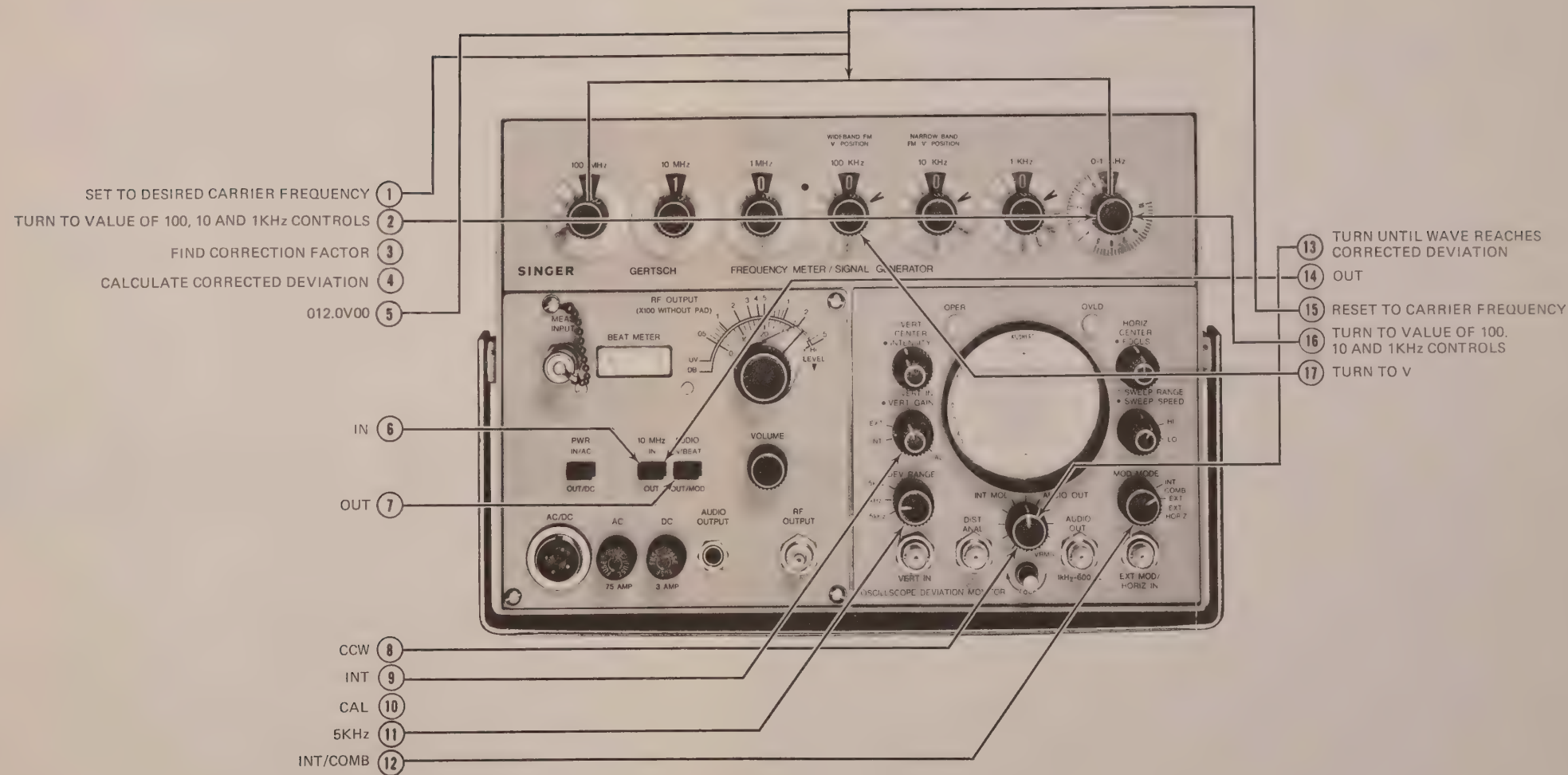


Figure 3-16. 60KHz Deviation – Quick Set-up

3-8. COMBINED INTERNAL/EXTERNAL (TWO-TONE) MODULATION.

Note: An external RF generator or transmitter must be used.

- 3-8-1. Set external audio oscillator to desired frequency and set to zero output.
- 3-8-2. Connect oscillator to EXT MOD/HORIZ IN.
- 3-8-3. Connect RF input to MEAS INPUT. Use direct or antenna input with attenuation to ensure zero or minimum initial input.
- 3-8-4. Position other controls as follows:
- | | | | |
|-----------------------|-----------|-----------------|---------------|
| 10MHz (in-out switch) | OUT | MOD MODE | INT / COMB |
| AUDIO | IN / BEAT | DEV RANGE | AS REQUIRED |
| VERT GAIN | CAL | INT MOD / AUDIO | CCW (not off) |
| VERT IN | INT | OUT | |
- 3-8-5. Set FM-10 frequency controls to desired carrier frequency. Example: 97.3527MHz.
- 3-8-6. Observe audible beat note output.
- 3-8-7. Turn 10 KHz or 100 KHz control to V position, according to whether narrowband or wideband modulation is required.
- 3-8-8. Turn 0-1 KHz control until zero beat note condition is obtained.
- 3-8-9. Offset by ± 2 MHz.



Figure 3-17. Frequency Controls Setup

- 3-8-10. Key transmitter (do not modulate) or increase output of RF generator, until operating indicator OPER lights.
- 3-8-11. If overload indicator OVLD lights, decrease RF input until OPER lights and OVLD goes out.
- 3-8-12. Adjust VERT CENTER to align trace on screen.
- 3-8-13. Turn INT MOD / AUDIO OUT control CW until wave height reaches desired deviation.
- 3-8-14. Increase output of external oscillator until wave height on CRT reaches total deviation required (internal 1 KHz and external combined).
- 3-8-15. Disconnect RF signal source from MEAS INPUT.

3-8-16. Re-set FM-10 to transmitter frequency by removing ± 2 MHz offset.

3-8-17. The FM-10/ODM-1 is now supplying two-tone FM modulation at the desired carrier frequency.

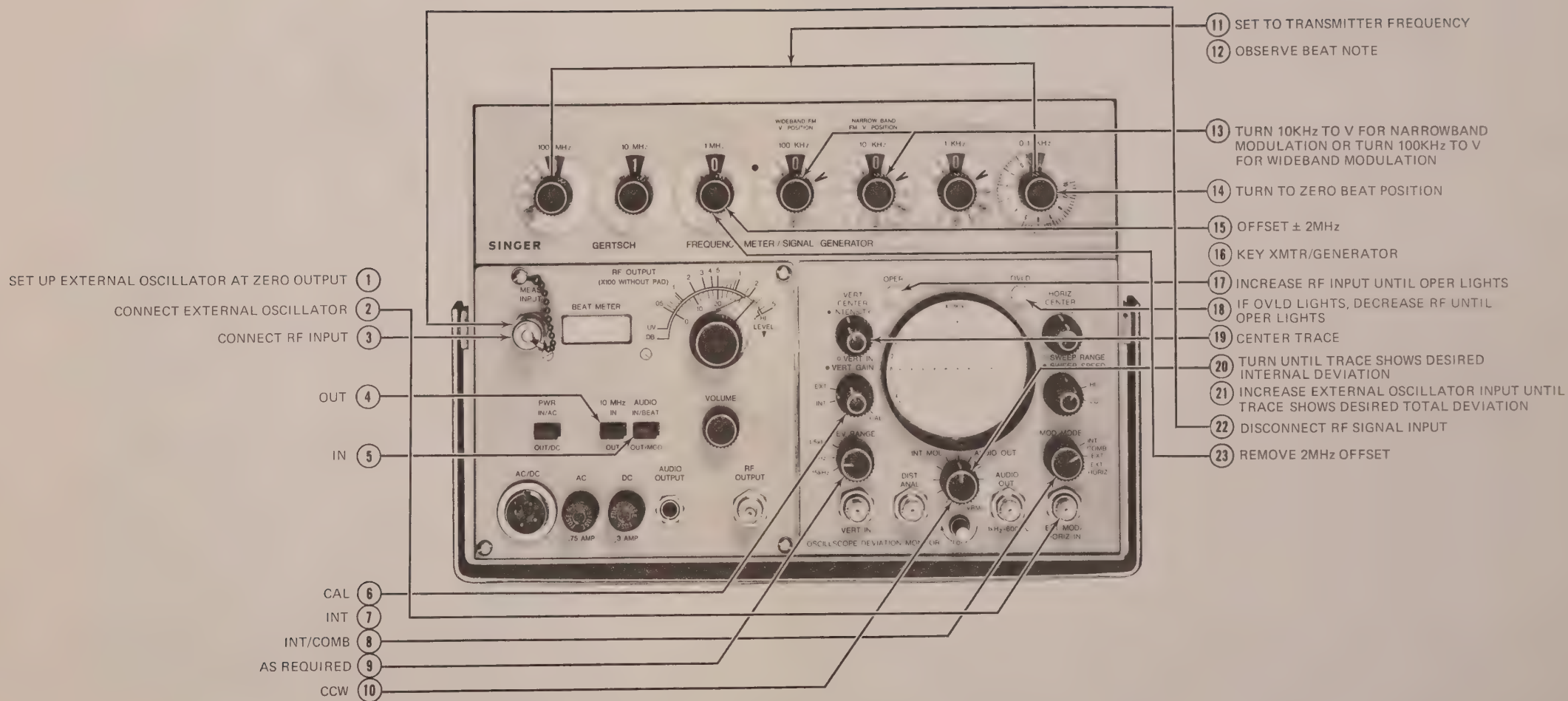
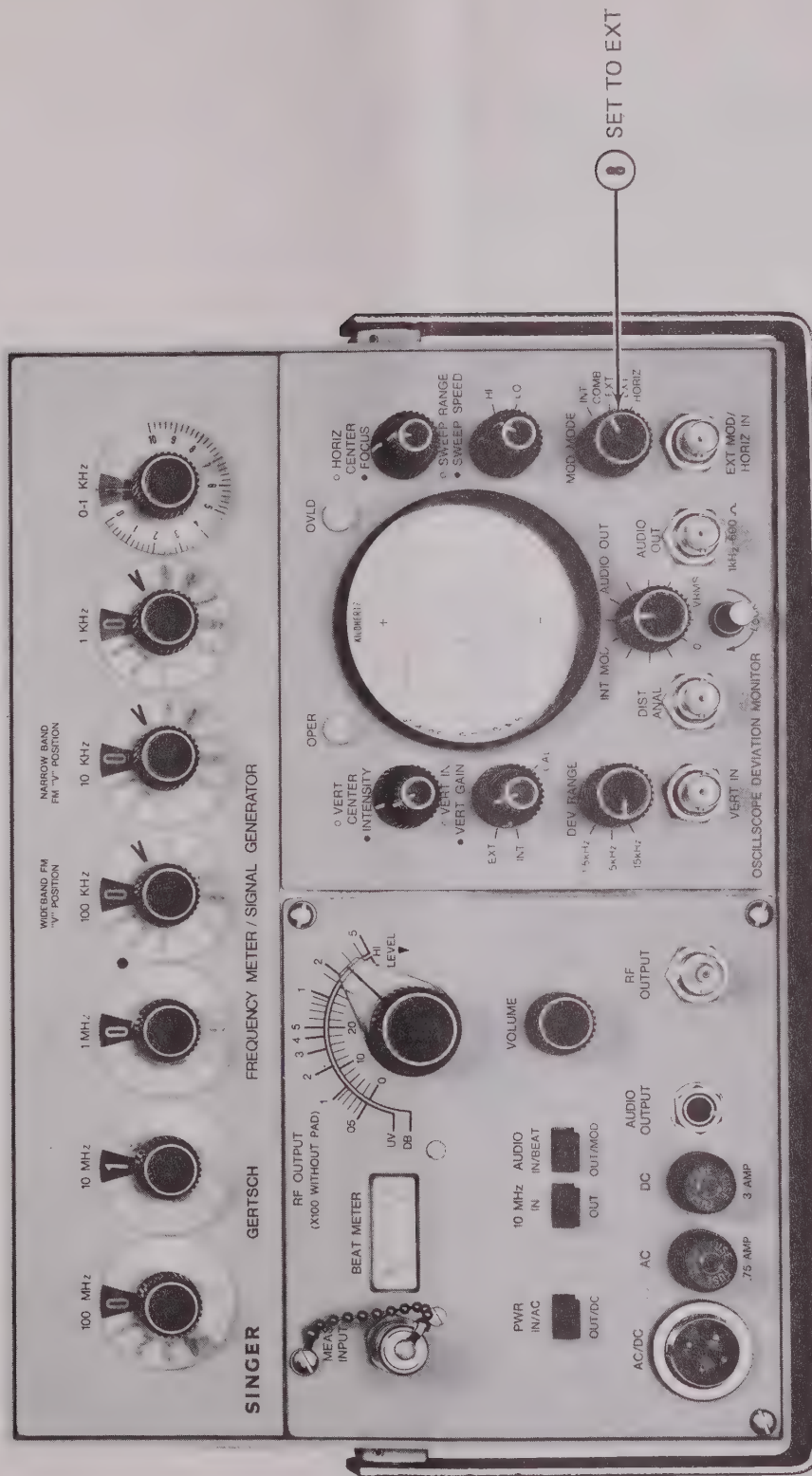


Figure 3-18. Two-Tone Modulation — Quick Set-up

3-9. EXTERNAL MODULATION ONLY. Repeat 3-8 with MOD MODE switch at EXT and omit internal modulation (step 3-8-13).

Note: Internal 1 KHz modulation oscillator is out of circuit when MOD MODE is at EXT.



SET UP AS FOR TWO-TONE MODULATION (FIGURE 3-18)
EXCEPT SET MOD MODE SWITCH TO EXT AT STEP 8.

Figure 3-19. External Modulation Only – Quick Set-up

3-10. AUDIO TEST TONE GENERATION

Note: The 1 KHz modulation tone developed by the FM-10/ODM-1 is available at all times at the AUDIO OUT connector for testing of transmitters and repeaters.

3-10-1. Connect transmitter microphone input to AUDIO OUT.

3-10-2. Turn INT MOD/AUDIO OUT control to level desired (a maximum of 1 vrms into 600 ohms is available).

3-10-3. The FM-10/ODM-1 is now supplying a 1 KHz tone with 600 ohms output impedance.

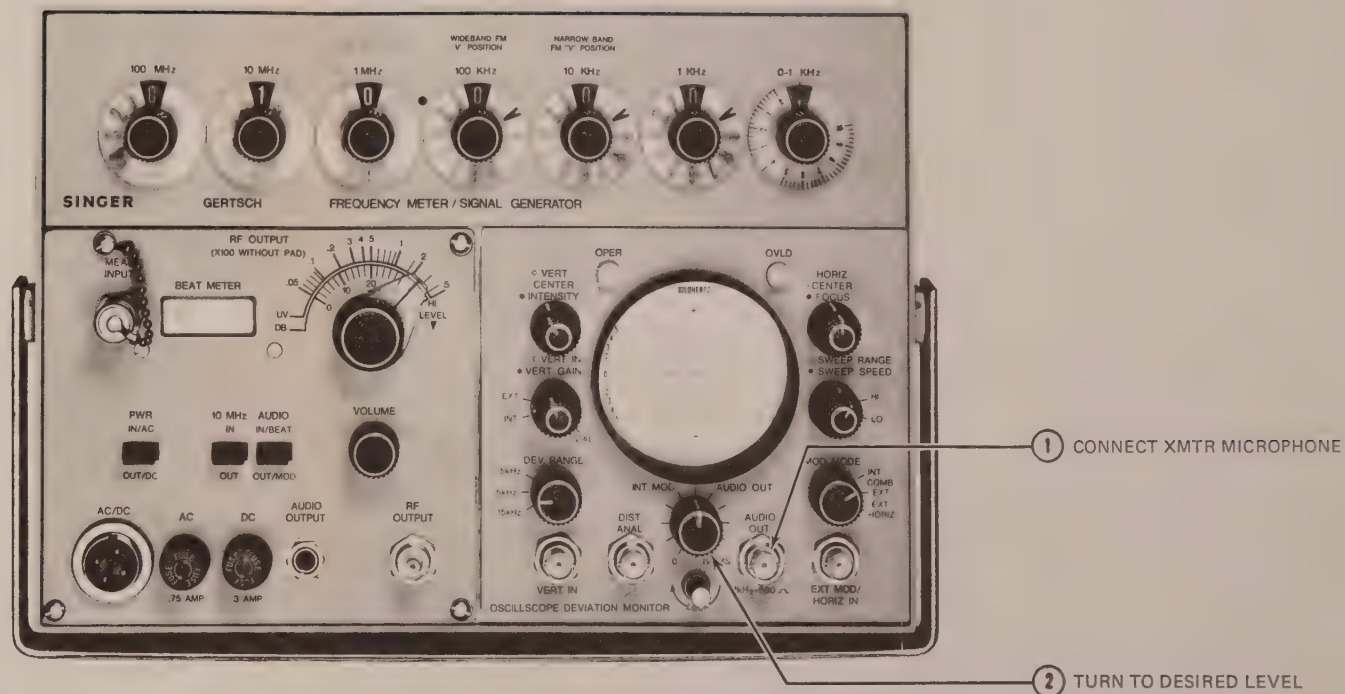


Figure 3-20. Audio Test Tone Generation – Quick Set-up

- 3-11. USE AS A GENERAL PURPOSE OSCILLOSCOPE.
- 3-11-1. INTERNAL HORIZONTAL SWEEP.
- 3-11-2. Turn VERT IN control to EXT.
- 3-11-3. For maximum sensitivity turn VERT GAIN control fully CW with DEV RANGE switch in the 1.5 KHz position.
- 3-11-4. Connect signal to be displayed on CRT to VERT IN. (Signal must be within 50 Hz to 30 KHz range.)
- 3-11-5. Turn MOD MODE switch to INT/COMB or EXT.
- 3-11-6. Adjust VERT GAIN control and DEV RANGE switch for suitable trace height.
- 3-11-7. Turn SWEEP RANGE switch to HI or LO for coarse adjustment of horizontal display.
- 3-11-8. Adjust SWEEP SPEED control for number of cycles to be displayed.
- 3-11-9. EXTERNAL HORIZONTAL SWEEP.
- 3-11-10. Repeat 3-9-1 through 3-9-8, except turn MOD MODE to EXT HORIZ.
- 3-11-11. Connect EXT MOD/HORIZ IN to external sweep signal source.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL (see Figure 4-1)

4-1-1. The ODM-1 plug-in module derives its power supplies and signal input via the rear connector. It carries its own power switch to permit use of the mainframe while the plug-in is switched off. High voltage power supplies for the CRT are also developed within the module. The module utilizes the 2MHz IF output signal developed within the mainframe. There are four sub-assemblies in the ODM-1: IF board, vertical amplifier board, horizontal amplifier board and high voltage power supply board.

4-1-2. IF BOARD

The 2MHz IF frequency generated in the FM-10 is amplified by the 2MHz IF amplifier and supplied to the integrated circuit limiter/discriminator and level detector amplifier. The level detector amplifier output is rectified and applied to the operate and overload Schmitt triggers. These drive the operate and overload lights which provide indication of the IF signal level. The demodulated signal from the limiter/discriminator is supplied to the deviation range switch and the distortion analyzer output on the front panel. The auxiliary audio amplifier supplies the recovered audio to the FM-10 audio system for monitoring. The 1KHz oscillator is a Wien-bridge type which provides for internal modulation of the FM-10. The 1KHz oscillator output is amplified by the 1KHz driver amplifier and supplied to the front panel for external use.

4-1-3. VERTICAL AMPLIFIER BOARD

The demodulated audio signal is supplied to the vertical amplifier board via the deviation range switch. The vertical amplifier is a high gain DC-coupled amplifier with differential outputs driving the CRT vertical deflection plates. A separate amplifier supplies the vertical signal to the horizontal sweep to provide internal sync. An external vertical input mode is provided for general oscilloscope use.

4-1-4. HORIZONTAL AMPLIFIER BOARD

The horizontal amplifier board consists of a sweep generator (sawtooth) and an amplifier. The frequency of the sawtooth generator is determined by the sweep range and sweep speed front panel control settings. A trigger signal is applied to the sweep generator to allow triggering from the vertical input signal. The horizontal deflection amplifier is a DC-coupled amplifier with differential outputs driving the CRT horizontal deflection plates. An external horizontal input mode is provided to drive the horizontal amplifier from an external source. This same input may also provide modulation of the FM-10 from an external source by appropriate switching.

4-1-5. HIGH VOLTAGE POWER SUPPLY BOARD

The high voltage power supply in a DC-DC converter which generates the 800V and 300V required for the CRT. An additional negative supply of -15V is provided for the vertical and horizontal deflection amplifiers.

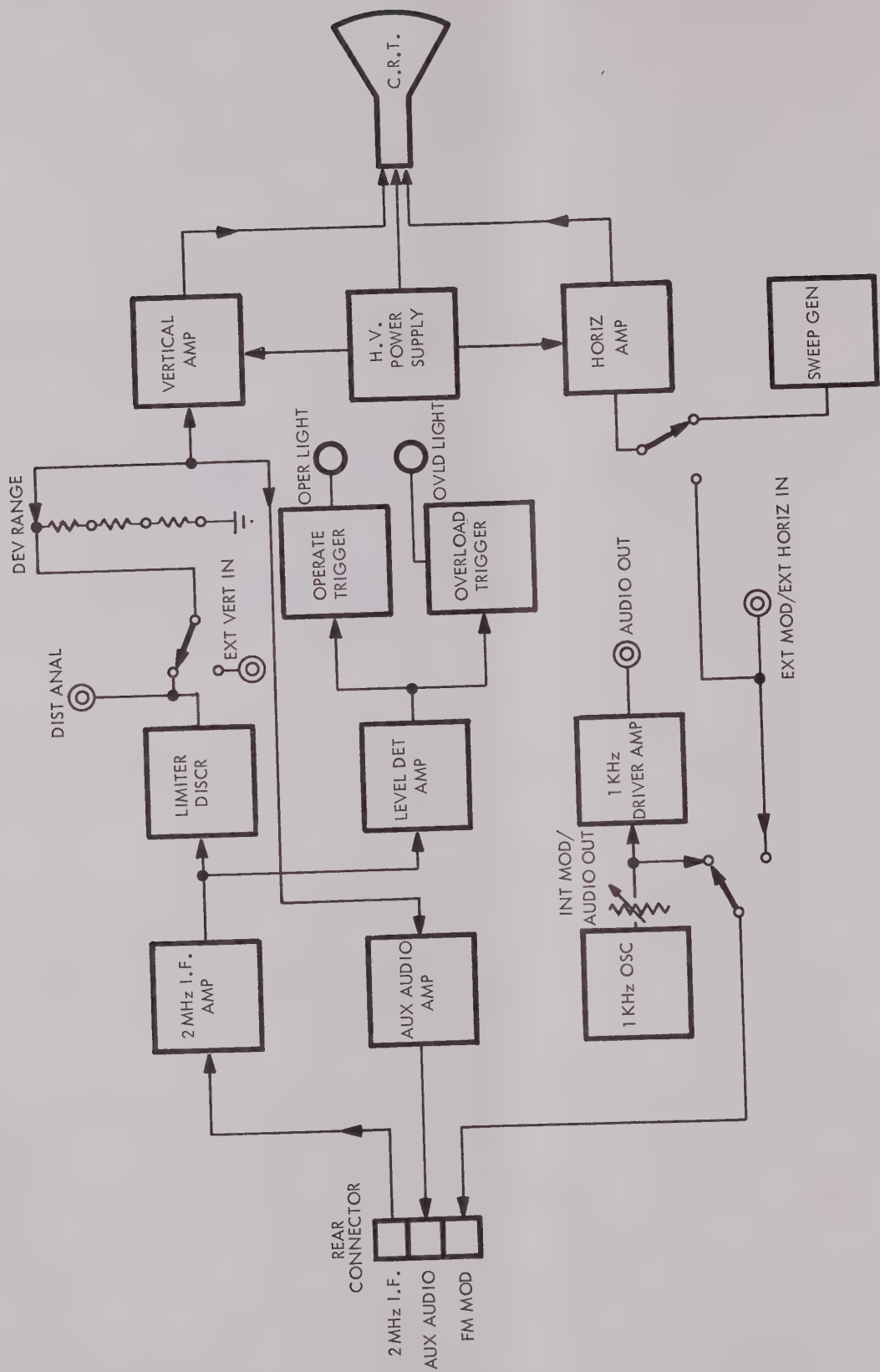


Figure 4-1. ODM Block Diagram

4-2. MODULATION

4-2-1. For modulation to occur, either the 100KHz or the 10KHz decade switches (on the FM-10 mainframe) must be in the V position. The 100KHz decade is set to V when the required deviation is greater than 6KHz (wideband modulation). The 10KHz decade is set to V when the deviation is less than 6KHz (narrowband modulation). (See Figure 4-2.)

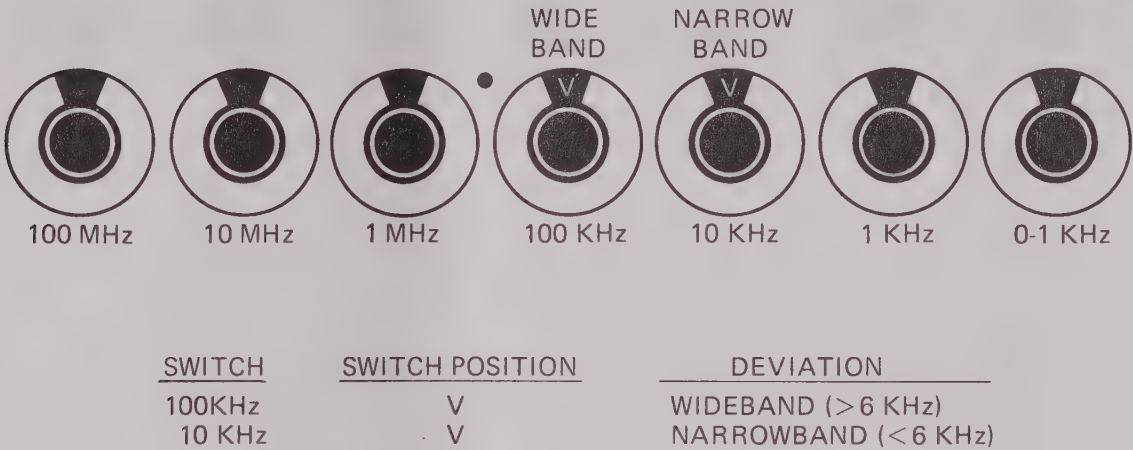


Figure 4-2. Controls Positions for Modulation

4-2-2. When the 100KHz switch is at V, the 10KHz and 1KHz switches are inoperative. Similarly when the 10KHz is at V, the 1KHz switch is inoperative.

To compensate for the fact that these switches are inoperative, the 0-1KHz control is designed to take over their functions and is set to the value that would otherwise be set up on the decade switches. For example, suppose a frequency of 197.8326MHz is to be set for (a) narrowband deviation, and (b) wideband deviation.

- a. For narrowband deviation the decades are set up as in Figure 4-3a. The 0-1KHz control is set to 3.26 to compensate for the fact that the 10KHz and 1KHz controls are inoperative.

Note: Due to lack of resolution, the 0-1KHz control can only be set to two places, so in practice it would be set to 3.2.

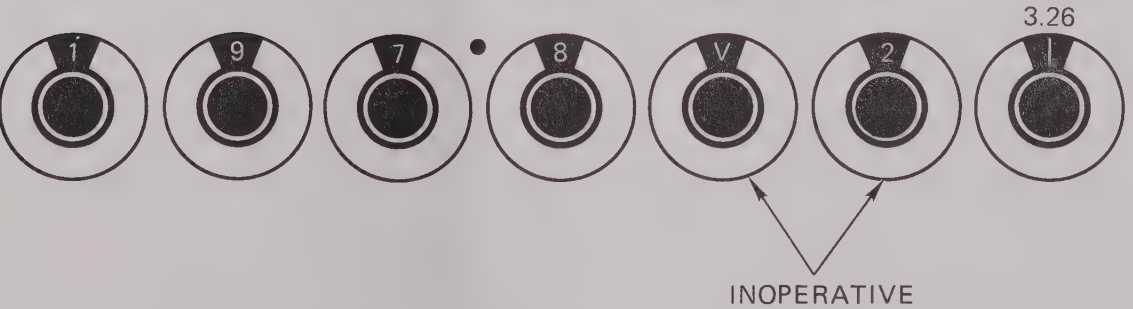


Figure 4-3a. Frequency Controls Setup

- b. For wideband deviation, the decades are set up as in Figure 4-3b. The 0-1KHz control is set to 8.326 to compensate for the fact that the 100KHz, 10KHz and 1KHz controls are inoperative.

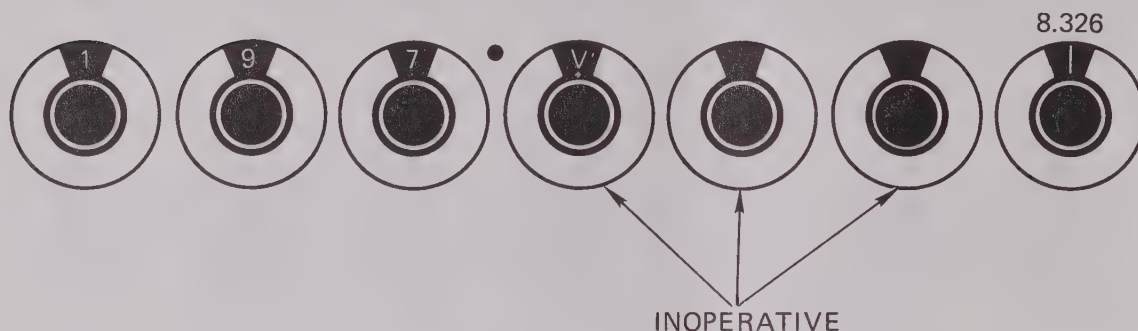


Figure 4-3b. Frequency Controls Setup

- 4-2-3. However, the deviation is only calibrated when the 0-1KHz control is in the zero position. Therefore, when the FM-10/ODM-1 is used for internal modulation without an external RF generator the 0-1KHz control must be recalibrated for use at each test frequency. This is because the circuit of which the 0-1KHz control is a part is also used to generate the modulation tone. Because it is non-linear, the degree of deviation varies with dial setting. It is therefore necessary to calculate an amended deviation using a correction factor derived from the deviation correction chart, Figure 3-5. A general description of the correction procedure is given in the example below.
- 4-2-4. Example: Suppose the frequency 197.8325MHz is to be modulated to 14KHz deviation. The frequency controls will be set as in Figure 4-4.



Figure 4-4. Typical Frequency Control Set-up

Note that the 0-1KHz control will be set to 8.325. To modulate the carrier to a deviation of 14KHz with the 0-1KHz control to the 8.325 position, it is first necessary to modulate the carrier to a corrected deviation with the 0-1KHz control in the zero (calibrated) position. To do this, an IF signal of 2MHz is generated internally by setting the frequency controls to 012.000 (12MHz) and switching in an internal 10KHz signal (Figure 4-5.)

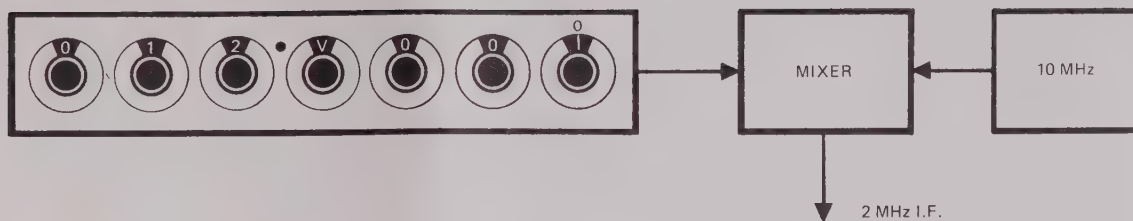


Figure 4-5. I.F. Generation

Since the frequency controls are now set for 12.000MHz, the 0-1KHz control will be in the zero position. However, when the frequency controls are finally re-set to 197.8325MHz, the 0-1KHz control will be in the 8.325 position. It is therefore necessary to make a correction by referring to the deviation correction chart (Figure 3-8). Find the correction factor corresponding to a set of 8.325 which is 2.33 and divide it into the desired deviation of 14KHz.

$$14\text{KHz} \div 2.33 = 6\text{KHz.}$$

The ODM-1 should therefore be set for a corrected deviation of 6KHz. The 10MHz signal is now removed and the frequency controls are re-set from 12MHz to 197.8325MHz. The 0-1KHz control position will now be changed from 0 to 8.325, so the deviation will change from 6KHz to 14KHz, the desired value.

SECTION V

MAINTENANCE

5-1. GENERAL

- 5-1-1. Check the ODM-1 for FM deviation calibration every 90 days. The ODM-1 is self-checking and no test equipment or external connectors are required.

5-2. FM DEVIATION CALIBRATION CHECK PROCEDURE

- 5-2-1. Turn on power to ODM-1 and allow one minute warm up.

- 5-2-2. Set controls on FM-10 as follows:

Frequency controls	012.000 (0-1KHz control at out position)
10MHz Switch	IN

The ODM-1 operate light should now be lit.

- 5-2-3. Set ODM-1 controls as follows:

VERT IN	INT		DEV RANGE	5KHz
VERT GAIN	CAL (fully CW)		MOD MODE	INT / COMB

Set intensity and focus controls for sharpest trace. Center the trace on the CRT screen.

- 5-2-4. Set FM-10 frequency controls to 012.005 (0-1KHz at OUT position). The trace should move to the upper 5KHz graduation on the CRT screen. If the indicated peak deviation is not 5KHz, re-calibrate the ODM-1.

5-3. CALIBRATION

- 5-3-1. Equipment required: Patch cable, Gertsch Model PC-2653.

- 5-3-2. Remove the ODM-1 from the FM-10 and use the patch cable to re-connect the plug-in with the main-frame.

- 5-3-3. Repeat the deviation check procedure, paragraphs 5-2-1 through 5-2-4.

- 5-3-4. Adjust R122 on the vertical amplifier board (refer to Figure 5-1) until the trace lines up with the 5KHz graduation on the screen.

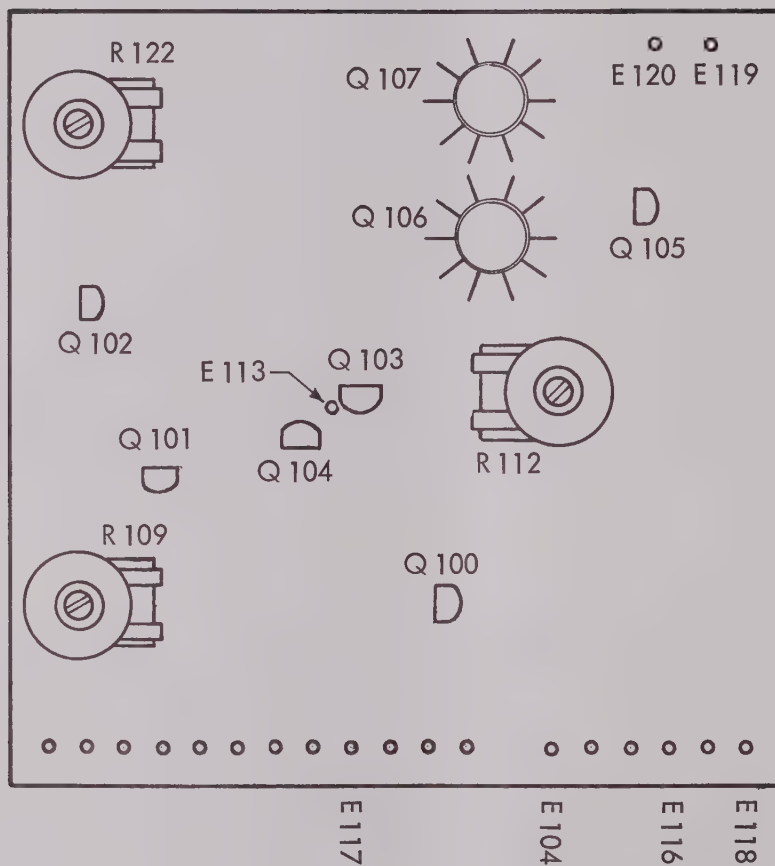


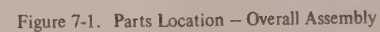
Figure 5-1. Vertical Amplifier Board

SECTION VI
SCHEMATIC DIAGRAM

Figure 6-1. Schematic Diagram – ODM-1

SECTION VII

PARTS LIST



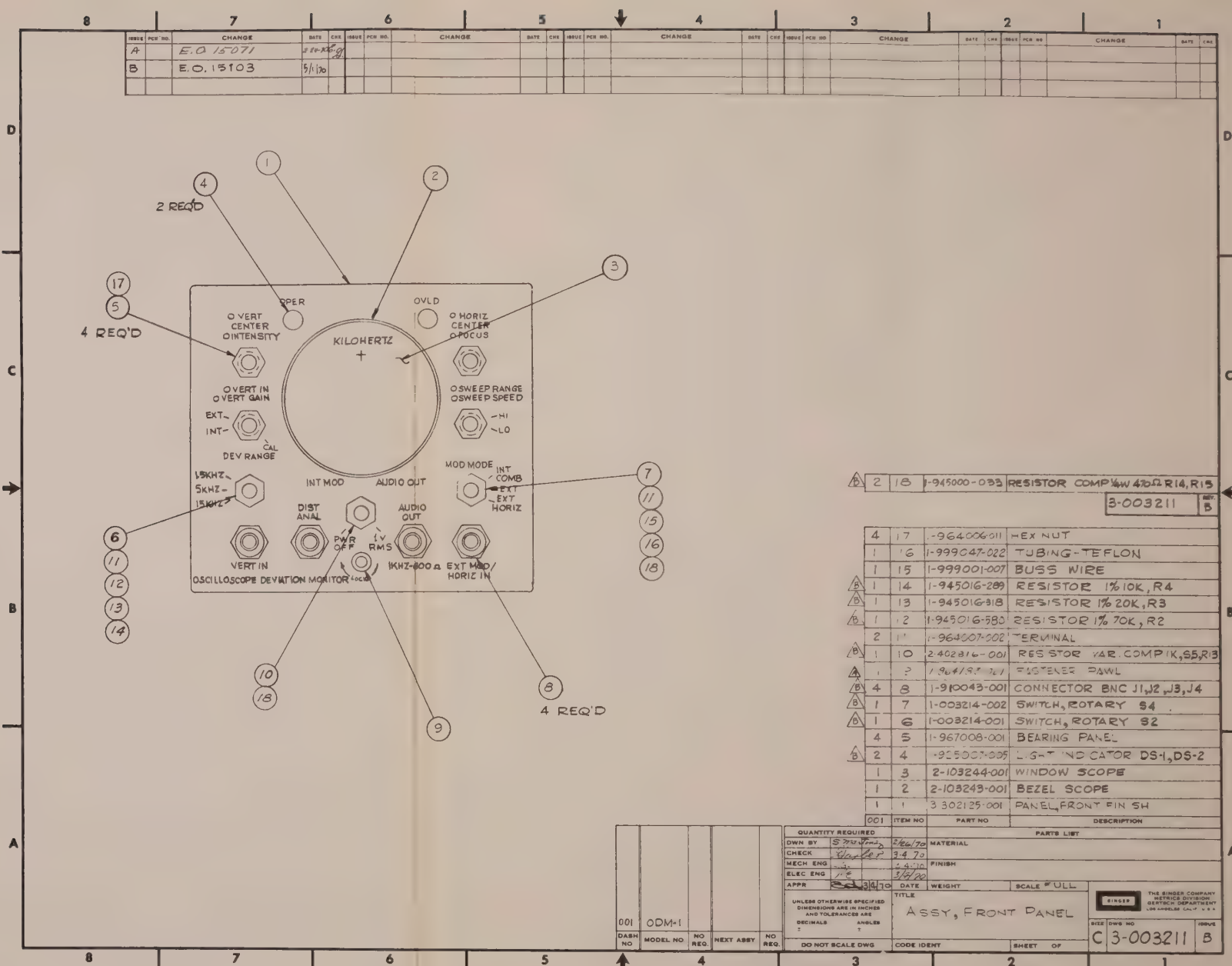


Figure 7-2. Parts Location - Front Panel

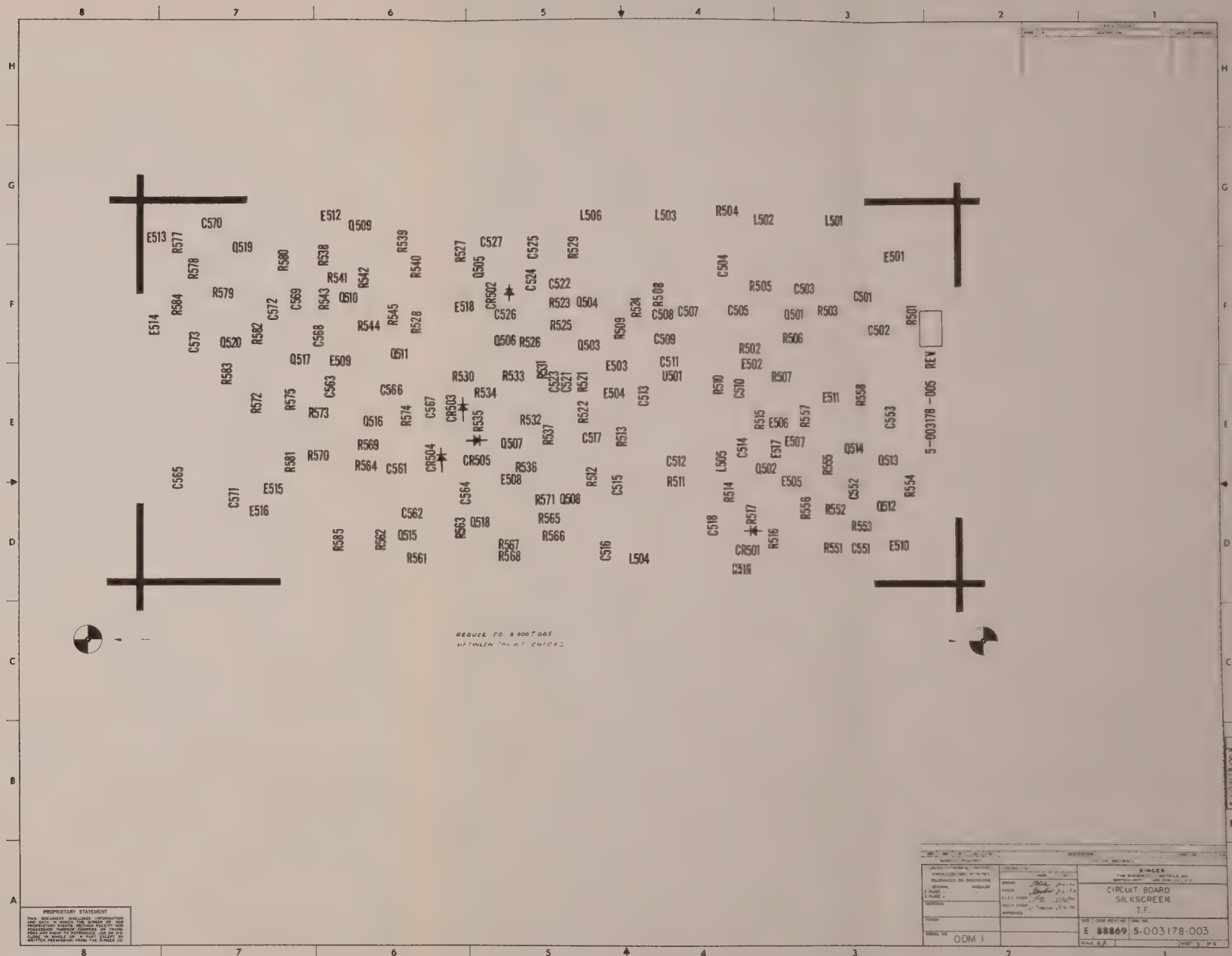


Figure 7-3. Parts Location - IF Board

IF BOARD PARTS LIST
(Refer to Figure 7-3)

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
C501, C502	Capacitor, Mica 5%, 500VDC, 1200pf	1-900004-013			2
C503	Capacitor Mica 5%, 500VDC, 150pf	1-900003-034			1
C504	Capacitor Met. Pl. 20%, 250VDC, 0.1 μ f	1-900001-013			1
C505	Capacitor Mica 5%, 500VDC, 150pf	1-900003-034			1
C507	Capacitor Mica 10%, 500VDC, 5pf	1-900003-004			1
C508	Capacitor Mica 5%, 500VDC, 150pf	1-900003-034			1
C509	Capacitor Mica 5%, 500VDC, 1200pf	1-900004-013			1
C510	Capacitor Met. Pl. 20%, 250VDC, 0.1 μ f	1-900001-013			1
C511	Capacitor Met. Pl. 20%, 250VDC, 0.047 μ f	1-900001-009			1
C512	Capacitor Mica 5%, 500VDC, 150pf	1-900003-034			1
C513	Capacitor Mica 5%, 500VDC, 47pf	1-900003-021			1
C514, C515	Capacitor Met. Pl. 20%, 250VDC, 0.1 μ f	1-900001-013			2
C516	Capacitor Elect. 25VDC, 25 μ f	1-900039-001			1
C517	Capacitor Ceramic Disc, 500VDC, 0.005 μ f	1-900012-004			1
C518	Capacitor Ceramic Disc, 500VDC, 0.001 μ f	1-900012-002			1
C519	Capacitor Met. Pl. 20%, 250VDC, 0.1 μ f	1-900001-013			1
C521	Capacitor Met. Pl. 20%, 250VDC, 0.010 μ f	1-900001-001			1
C522	Capacitor Mica 5%, 500VDC, 150pf	1-900003-034			1
C523, C524	Capacitor Met. Pl. 20%, 205VDC, 0.010 μ f	1-900001-001			2
C525	Capacitor Met. Pl. 20%, 250VDC, 0.1 μ f	1-900001-013			1
C526	Capacitor, Elect. 25VDC, 25 μ f	1-900039-001			1
C527	Capacitor Met. Pl. 20%, 250VDC, 0.1 μ f	1-900001-013			1
C551	Capacitor Met. Pl. 20%, 250VDC, 0.1 μ f	1-900001-013			1
C552	Capacitor Mica, 5%, 500VDC, 100pf	1-900003-030			1

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
C553	Capacitor, Elect., 25VDC, 25 μ f	1-900039-001			1
C561, C562	Capacitor Met. Pl. 20%, 250VDC, 0.01 μ f	1-900001-001			2
C563	Capacitor Mica, 5%, 500VDC, 100pf	1-900003-030			1
C564	Capacitor Elect., 25VDC, 25 μ f	1-900039-001			1
C565	Capacitor, Elect., 25VDC, 200 μ f	1-900039-002			1
C566	Capacitor, Elect., 25VDC, 25 μ f	1-900039-001			1
C567	Capacitor, Elect., 25VDC, 2 μ f	1-900023-016			1
C568— C571	Capacitor, Elect., 25VDC, 25 μ f	1-900039-001			4
C572	Capacitor Met. Pl., 20%, 250VDC, 0.047 μ f	1-900001-009			1
C573	Capacitor, Elect., 25VDC, 25 μ f	1-900039-001			1
CR501	Diode, Zener	1-913003-009			1
CR502, CR503	Diode	1-913007-001			2
CR504, CR505	Diode	1-913005-001			1
L501— L504	Inductor, Variable, 30 - 60 uh	1-906006-003			4
L505	Inductor, Fixed 2.5 uh	1-906002-054			1
L506	Inductor, Variable, 30 - 60 uh	1-906006-003			1
Q501— Q511	Transistor	1-958000-001			11
Q512	Transistor, FET	1-958031-003			1
Q513	Transistor	1-958000-002			1
Q514— Q516	Transistor	1-958000-001			3
Q517	Transistor	1-958000-002			1
Q518	Transistor, FET	1-958044-003			1

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
Q519, Q520	Transistor	1-958000-001			1
R501	Resistor, carbon, 1/4W., 10%, 56 ohms	1-945000-022			1
R502	Resistor, carbon, 1/4W., 10%, 68K.	1-945000-047			1
R503	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-041			1
R504	Resistor, carbon, 1/4W., 10%, 470 ohms	1-945000-033			1
R505	Resistor, carbon, 1/4W., 10%, 100K.	1-945000-061			1
R506, R507	Resistor, carbon, 1/4W., 10%, 470 ohms	1-945000-033			2
R508	Resistor, carbon, 1/4W., 10%, 100K.	1-945000-061			1
R509	Resistor, carbon, 1/4W., 10%, 1K.	1-945000-041			1
R510	Resistor, carbon, 1/4W., 10%, 470 ohms	1-945000-033			1
R511	Resistor, carbon, 1/4W., 10%, 10K.	1-945000-049			1
R512	Resistor, carbon, 1/4W., 10%, 10 ohms	1-945000-013			1
R513	Resistor, carbon, 1/4W., 10%, 12K.	1-945000-050			1
R514, R515	Resistor, carbon, 1/4W., 10%, 1K.	1-945000-037			2
R516	Resistor, variable, $\pm 30\%$, 1K.	1-945007-004			1
R517	Resistor, carbon, 1/4W., 10%, 10K.	1-945000-049			1
R521	Resistor, carbon, 1/4W., 10%, 270 ohms	1-945000-030			1
R522	Resistor, carbon, 1/4W., 10%, 120 ohms	1-945000-026			1
R523	Resistor, carbon, 1/4W., 10%, 10K.	1-945000-049			1
R524	Resistor, carbon, 1/4W., 10%, 3.3K	1-945000-043			1
R525	Resistor, carbon, 1/4W., 10%, 10 ohms	1-945000-013			1
R526	Resistor, carbon, 1/4W., 10%, 100 ohms	1-945000-025			1
R527, R528	Resistor, variable, $\pm 10\%$, 1K.	1-945056-007			2
R529	Resistor, carbon, 1/4W., 10%, 100 ohms	1-945000-025			1
R530	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-041			1

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
R531, R532	Resistor, carbon, 1/4W., 10%, 330 ohms	1-945000-031			2
R533	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-041			1
R534	Resistor, carbon, 1/4W., 10%, 1K	1-945000-047			1
R535	Resistor, carbon, 1/4W., 10%, 2.7K	1-945000-042			1
R536	Resistor, carbon, 1/4W., 10%, 10K	1-945000-049			1
R537, R538	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-041			2
R539 R540	Resistor, carbon, 1/4W., 10%, 330 ohms	1-945000-031			2
R541	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-041			1
R542	Resistor, carbon, 1/4W., 10%, 1K	1-945000-037			1
R543	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-042			
R544	Resistor, carbon, 1/4W., 10%, 10K	1-945000-049			1
R545	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-041			1
R548	Resistor, carbon, 1/4W., 10%, 560 ohms	1-945000-034			1
R551	Resistor, carbon, 1/4W., 10%, 10K	1-945000-049			1
R552	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-042			1
R553	Resistor, carbon, 1/4W., 10%, 10M	1-945000-085			1
R554- R557	Resistor, carbon, 1/4W., 10%, 470 ohms	1-945000-033			4
R558	Resistor, carbon, 1/4W., 10%, 10 ohms	1-945000-013			1
R561	Resistor, carbon, 1/4W., 10%, 15K	1-945000-051			1
R562	Resistor, variable, $\pm 30\%$, 5K	1-945007-006			1
R563	Resistor, carbon, 1/4W., $\pm 10\%$, 1K	1-945000-051			1
R564	Resistor, carbon, 1/4W., $\pm 10\%$, 1K	1-945000-037			1
R565	Resistor, carbon, 1/4W., $\pm 10\%$, 150 ohms	1-945000-027			1
R566	Resistor, variable, $\pm 30\%$, 100 ohms	1-945007-001			1
R567	Resistor, carbon, 1/4W., $\pm 10\%$, 56 ohms	1-945000-022			1

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
R568	Resistor, Thermistor, 300 ohms	1-945070-001			1
R569, R570	Resistor, carbon, 1/4W., 10%, 10M	1-945000-041			2
R571	Resistor, carbon, 1/4W., 10%, 47K	1-945000-057			1
R572	Resistor, carbon, 1/4W., 10%, 100 ohms	1-945000-025			1
R573	Resistor, carbon, 1/4W., 10%, 2.2K	1-945000-041			1
R574	Resistor, carbon, 1/4W., 10%, 680 ohms	1-945000-035			1
R575	Resistor, carbon, 1/4W., 10%, 270 ohms	1-945000-036			1
R577	Resistor, carbon, 1/4W., 10%, 820 ohms	1-945000-036			1
R578	Resistor, carbon, 1/4W., 10%, 10K	1-945000-049			1
R579	Resistor, carbon, 1/4W., 10%, 1K	1-945000-037			1
R580	Resistor, carbon, 1/4W., 10%, 100 ohms	1-945000-025			1
R581	Resistor, carbon, 1/4W., 10%, 10 ohms	1-945000-013			1
R582	Resistor, carbon, 1/4W., 10%, 22K	1-945000-053			1
R583	Resistor, carbon, 1/4W., 10%, 330 ohms	1-945000-031			1
U501	Integrated Circuit Disc	1-926031-001			1

VERTICAL AMPLIFIER BOARD PARTS LIST
(Refer to Figure 7-4)

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
C100	Capacitor Dipped MICA – Size 15	1-900003-021			1
C101	Capacitor, Variable Ceramic	1-900031-001			1
C102	Capacitor, Metalized Plastic	1-900001-001			1
C103	Capacitor, Electrolytic	1-900000-021			1
C104, C105	Capacitor, Metalized Plastic	1-900001-013			2
CR100	Diode, Zener	1-913003-020			1
CR101, CR102	Diode	1-913000-001			2
Q100	Transistor, Junction Field Effect	1-958002-002			1
Q101	Transistor	1-958000-001			1
Q102	Transistor, Junction Field Effect	1-958000-002			1
Q103, Q104, Q105	Transistor	1-958000-001			3
Q106, Q107	Transistor	1-958004-001			2
R100	Resistor, Composition 1/4W.	1-945000-061			1
R101	Resistor, Composition 1/4W.	1-945000-085			1
R102	Resistor, Composition 1/4W	1-945000-073			1
R103	Resistor, Composition 1/4W.	1-945000-061			1
R104	Resistor, Composition 1/4W.	1-945000-053			1
R105	Resistor, Composition 1/4W.	1-945000-037			1
R106	Resistor, Composition 1/4W.	1-945000-013			1
R107	Resistor, Composition 1/4W.	1-945000-049			1
R108	Resistor, Composition 1/4W.	1-945000-036			1
R109	Resistor, Variable Comp., Perpend.	1-945006-007			1
R110	Resistor, Variable Comp., Paralleled	1-945005-007			1

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
R111	Resistor, Composition 1/4W.	1-945000-041			1
R112	Resistor, Variable Comp., Perpend.	1-945006-015			1
R113	Resistor, Composition 1/4W.	1-945000-049			1
R114	Resistor, Composition 1/4W.	1-945000-043			1
R115	Resistor, Composition 1/4W	1-945000-037			1
R116	Resistor, Composition 1/4W.	1-945000-053			1
R117	Resistor, Composition 1/4W.	1-945000-033			1
R118	Resistor, Composition 1/4W	1-945000-073			1
R119	Resistor, Composition 1W.	1-945002-057			1
R120	Resistor, Composition 1/4W.	1-945000-046			1
R121	Resistor, Composition 1/4W.	1-945000-021			1
R122	Resistor, Variable Comp., Paralleled	1-945005-007			1
R123	Resistor, Composition 1W.	1-945002-057			1
R124	Resistor, Composition 1/4W.	1-945000-046			1

HORIZONTAL AMPLIFIER BOARD PARTS LIST
(Refer to Figure 7-5)

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
C200	Capacitor, Dipped Plastic Non-Inductive	1-900005-101			1
C201	Capacitor, Dipped Plastic Non-Inductive	1-900005-004			1
C202, C203	Capacitor, Metalized Plastic	1-900001-013			2
C204, C205	Capacitor, Electrolytic	1-900000-021			2
CR200, CR201	Diode	1-913005-001			2
Q200, Q201	Transistor	1-958000-002			2
Q202	Transistor	1-958000-002			1
Q203	Transistor, Junction Field Effect	1-958002-002			1
Q204, Q205	Transistor	1-958004-001			2
R200	Resistor, Composition 1/4W.	1-945000-041			1
R201	Resistor, Composition 1/4W.	1-945000-051			1
R202	Resistor, Variable Comp., Parallel	1-945005-019			1
R203	Resistor, Composition 1/4W.	1-945000-053			1
R204	Resistor, Variable Comp., Parallel	1-945005-015			1
R205	Resistor, Composition 1/4W.	1-945000-085			1
R206	Resistor, Composition 1/4W.	1-945000-049			1
R207, R208	Resistor, Composition 1/4W.	1-945000-053			2
R209	Resistor, Composition 1/4W.	1-945000-037			1
R210	Resistor, Composition 1W.	1-945002-057			1
R211	Resistor, Composition 1/4W.	1-945000-046			1
R212	Resistor, Composition 1/4W.	1-945000-029			1
R213	Resistor, Variable Comp., Paralleled	1-945005-007			1
R214	Resistor, Composition 1W.	1-945002-057			1

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
R215	Resistor, Composition 1/4W.	1-945000-046			1
R216	Resistor, Composition 1/4W.	1-945000-044			1
R217	Resistor, Variable Comp., Paralleled	1-945005-027			1
R218	Resistor, Composition 1/4W.	1-945000-061			1

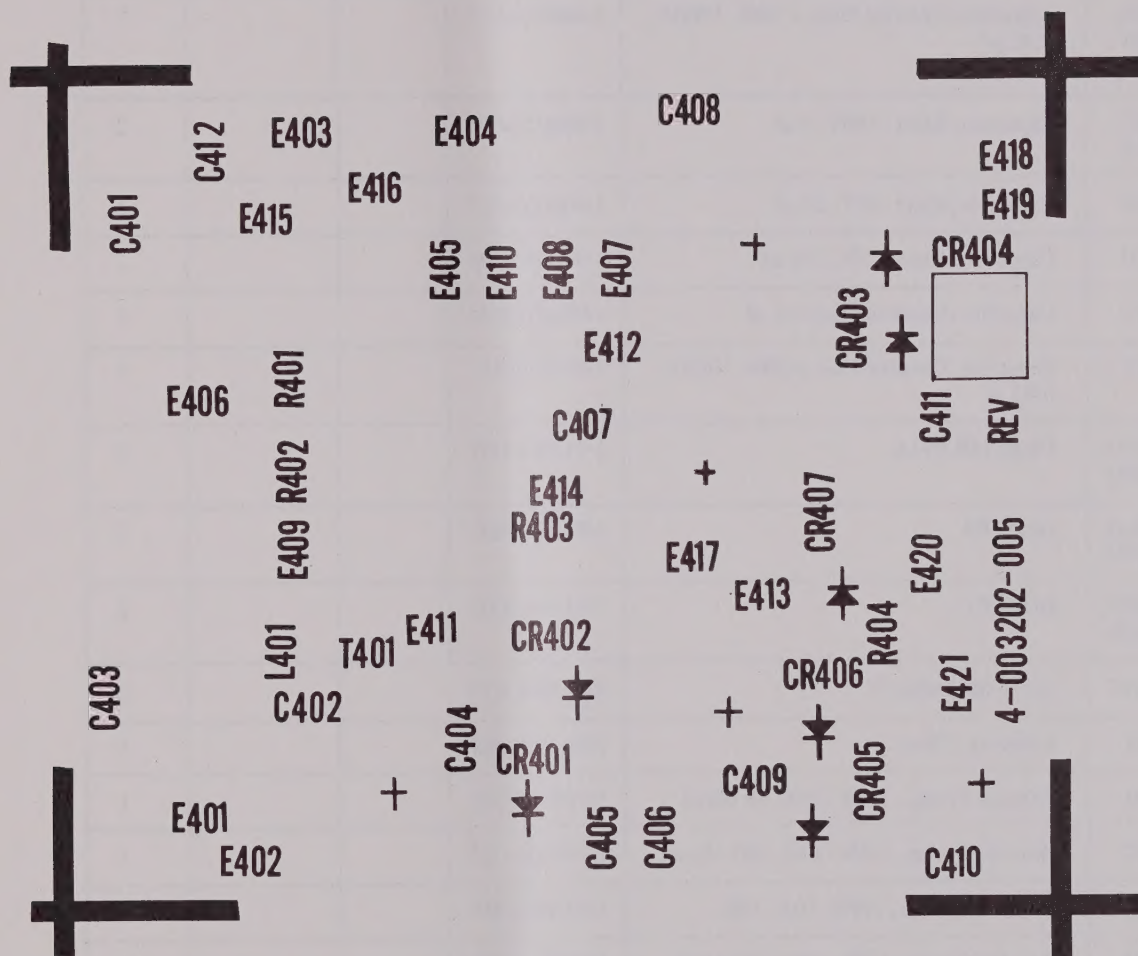


Figure 7-6. Parts Location – HV Power Supply Board

HV POWER SUPPLY BOARD PARTS LIST
(Refer to Figure 7-6)

REF DES	DESCRIPTION	SINGER P/N	MFR	MFR'S P/N	QTY
C401	Capacitor, Metl. Pl. $\pm 20\%$ 250V, 0.047 μf	1-900001-009			1
C402	Capacitor, Elect. 15V, 200 μf	1-900039-002			1
C403	Capacitor, Metl. Pl. $\pm 20\%$, 250V, 0.47 μf	1-900001-021			1
C404, C405, C406	Capacitor, Ceramic Disc, $\pm 20\%$, 1000V, 0.02 μf	1-900012-012			3
C407, C408	Capacitor, Elect. 350V, 4 μf	1-900011-001			2
C409	Capacitor, Elect. 35V, 25 μf	1-900000-021			1
C410	Capacitor, Elect. 25V, 100 μf	1-900039-004			1
C411	Capacitor, Ceramic Disc, 0.1 μf	1-900012-005			1
C412	Capacitor, Ceramic Disc, $\pm 20\%$, 1000V, 0.02 μf	1-900012-012			1
CR401, CR402	Diode MR 991A	1-913043-002			2
CR403, CR404	Diode E4	1-913002-001			2
CR405, CR406	Diode E1	1-913002-001			2
CR407	Diode MZ1000-17	1-913004-017			1
L401	Inductor, Filter	1-003213-001			1
R401	Resistor Comp., 1/4W. 10%, 68 ohms	1-945000-023			1
R402	Resistor Comp., 1/4W. 10%, 680 ohms	1-945000-035			1
R403	Resistor, Comp., 1/4W. 10%, 10K	1-945000-049			1
R404	Resistor Comp., 1/4W. 10%, 100 ohms	1-945000-025			1
T401	Transformer	1-003206-001			1

